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THE AMERICAN GAS LIGHT JOURNAL

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BRIEFLY TOLD.

A PERSONAL BUDGET.—Mr. J. Armitage Drake, of Drakes' Limited, Halifax, England, arrived in New York, the 4th inst. Mr. Drake is here looking after his business interests, and to inspect the work now in progress on the plant of the New Bedford (Mass.) Gas and Edison Light Company, the contract for which, as has been been said before, is held by the Connelly Iron Sponge and Governor Company, the agent for the Drakes in this country.

MR. E. H. HOAGLAND, who was connected with the interests of the Welsbach Street Lighting Company, of America, in Chicago and the West, has resigned from that Company's service, the resignation being effective from the 1st inst.

MR. W. C. ANDERSON has resigned the position of Superintendent of the Port Chester branch of the Westchester Lighting Company, Mount Vernon, N. Y. He has identified himself with the Stanley Instrument Company, which concern he will represent in Europe as Sale's Agent. His headquarters will be in Paris, France. Mr. Anderson and his family sailed for Europe last Saturday. A pleasant incident in connection with his taking leave of his former subordinates in the Port Chester district, was their presentation to him of a handsome jeweled Masonic charm.

NOTES.——

TO-DAY the voters of Holland, Mich., will finally dispose of the question as to whether the gas works to be erected there are to be erected and controlled on public or private account.

AT the annual meeting of the St. Albans (Vt.) Gas Light Company the Directors chosen were: Samuel T. Bodine, Marshall Mason, Randolph Morgan, Walton Clark and Lewis Lillie. The annual reports submitted by Secretary and Treasurer Butterworth showed that the Company had enjoyed a prosperous year.

AT the annual meeting of the Omaha (Neb.) Gas Company the officers chosen were: Directors, Frank Murphy, Ben. B. Wood, Frank V. Hamilton, Samuel F. Bodine and Randall Morgan; President, Frank Murphy; Vice-President, George E. Barker; Treasurer, Isaac Battin; Secretary, George W. Clabaugh; Assistant Treasurer, Lewis Lillie.

AS was to be expected, the residents of Paris, France, are not in accord with the movement of certain American capitalists, amongst whom are Messrs. George O. Knapp, C. K. G. Billings and A. H. Brady, to secure control of the gas supply of that city. In fact it is not at all likely that the Parisians will part with the ownership of their gas works.

MR. WILLIAM J. BARKER, Superintendent of the electrical division of the works of the Denver (Col.) Gas and Electric Company, was presented with a beautiful service of silver the eve of New Year's, by the men under his immediate charge. The preliminaries were rather rough on Mr. Barker, who, when he was informed that the men wished to see him, at a certain time and place on the plant, in order that an important grievance could be settled, was quite certain it was a strike that confronted him.

NEARLY seven miles of additional mains were put down by the Omaha (Neb.) Gas Company last season. The highest output for any 24 hours in the year was reached in the last week in December, when 1,500,000 cubic feet were sent out.

Correspondence

[The JOURNAL is not responsible for the opinions expressed by correspondents.]

Mr. W. R. Herring on Some Statements Made at the Last Meeting of the American Gas Light Association, Respecting Inclined and Horizontal Retorts.

EDINBURGH AND LEITH CORPORATIONS GAS COMMISSIONERS,
CHIEF ENGINEER AND MANAGER'S OFFICE.
NEW STREET WORKS,
EDINBURGH, Dec. 17, 1902.

To the Editors AMERICAN GAS LIGHT JOURNAL:

You will, I am sure, permit me to address you in order to correct one or two misstatements, made in the course of a discussion[1] on Mr. Brown's[2] paper on the question of inclined retorts, reported in your issue of the 24th November last.

Mr. Littlehales is lamentably wrong in his references to the working at Edinburgh and Glasgow. In the year named (1900) I had only two settings of 18 retorts working on the inclined principle, amongst 992 horizontal retorts, working partly by machinery and partly by hand. Mr. Littlehales' comparisons and the conclusion he draws from them are, therefore, fallacious. At the same time, I would like to ask what possible bearing the cost of coal aud the returns for residual products can have upon the question of the cost of charging coal into the retorts and drawing the resulting coke therefrom.

Mr. Littlehales' experience in this country should have made him aware of the fact that the price of coal and the return for residual products vary in almost every case, in that of coal from $1.30 to $6 per ton of 2,240 pounds, depending upon the part of the country to which it is delivered, and that the return for residual products is equally variable. The illuminating power of the gas supplied in different parts also varies from 14 up to 26 candles. Even between Edinburgh and Glasgow the illuminating power is 25 candles in Edinburgh and 20 candles in Glasgow. In fact, there are innumerable conditions affecting the price of materials in different localities, which make a comparison under such a heading impossible. To attempt to compare Edinburgh with Glasgow, and much more so with Sheffield under these headings, and then to argue that machine charged horizontal retorts are more economical than inclined retorts is a process of reasoning I regret I cannot follow.

Mr. Brown himself also appears to have suggested that I have figured on obtaining from inclined retorts just as good work with the same coal as the horizontals were doing, and putting the labor on inclined retorts below that of horizontals. There is no doubt about the same coal yielding results fully equal, if not slightly superior, when carbonized in inclined retorts as compared with the horizontal system. I have proved this frequently, and again quite recently in Edinburgh. Neither is there any doubt whatever as to the labor costs being considerably less, my general experience being that these can be reduced by one-half as compared with the former costs for hand labor, and about 25 per cent. less than the former costs of machinery. The figures from my own working results at Granton at the present time, when I choose to publish them, will be highly interesting to all. As we have only been working about three months, I prefer to have a winter's experience before publishing any results whatever, excepting to say that they are of a highly satisfactory character.

The point at issue is as to the relative costs involved in labor in manipulating a ton of coal from its receipt at the retort house to the discharge of the coke and the refuse therefrom into the yard; a question in no ways involved in the cost of material. To avoid the slightly varying rates for wages in different localities, the figures might be stated in tons of coal manipulated per man per day of a given number of hours' work.

I am very much tempted, did time permit, to deal with many points raised in the discussion, such as the lesser yield of gas per ton of coal and of a poorer quality, furnaces requiring more fuel, retorts being more difficult to repair, and the greater cost to maintain the retorts; all of these have such a striking resemblance to the phantoms which have been so often raised on this side of the water and which have been finally laid low by those who have had a lengthened experience with the inclined retort system, that I need not say more than that they are the inevitable outcome of defective constructional work and design, and would result in an equal degree from a horizontal bench put up by inexperienced hands from a design by an inexperienced party.

Yours truly, W. R. HERRING.

1. See JOURNAL, Nov. 24, 1902, p. 782.
2. See JOURNAL, Nov. 17, 1902, p. 703.

[Concluded from Page 8.]

The Future of Coal Gas and Allied Illuminants.—No. III.

[The Third of a series of Cantor Lectures, delivered before the Society of Arts, London, England, by PROF. VIVIAN B. LEWES.]

High pressure incandescent lighting is a means to attain a definite end, and that end is to create centers of high total illuminating value in order to compete with arc lighting for outdoor work and large buildings. There is no doubt that the amount of light which can be obtained from the surface of a single mantle can be enormously increased thereby, but I do not think carefully made tests would reveal so great an economy in the units of light obtained per cubic foot of gas consumed as one would expect. I frankly admit that the high pressure incandescent companies have not shown any burning desire to submit their systems to my tender mercies, so that I have no personal knowledge of the actual results they are obtaining or of the cost at which it is being done; but continental practice has gone so far ahead of ours that one can make a comparison of the candle units per cubic foot of gas consumed.

Probably the greatest volume of light obtained by high pressure incandescent gas lighting is in the "Millenium" burner, which, with a double mantle, gives a light of 1,800 Hefner candles; which is obtained by a consuption of 2,250 liters of Berlin gas, or 79.46 cubic feet give 1,578.9 English candles, *i. e.*, 19.8 candles per cubic foot—a duty which can be obtained with a good "C" burner and mantle, if one is content with a volume of light per burner of under 100 candles.

In the "Millenium" burner I understand the gas is compressed under a pressure of over 6 feet of water. But one knows that over 30 candles per cubic foot can be obtained with Berlin gas at lower pressures, such as 10 inches, by the forms of apparatus in use here. But then the total volume of light is much smaller.

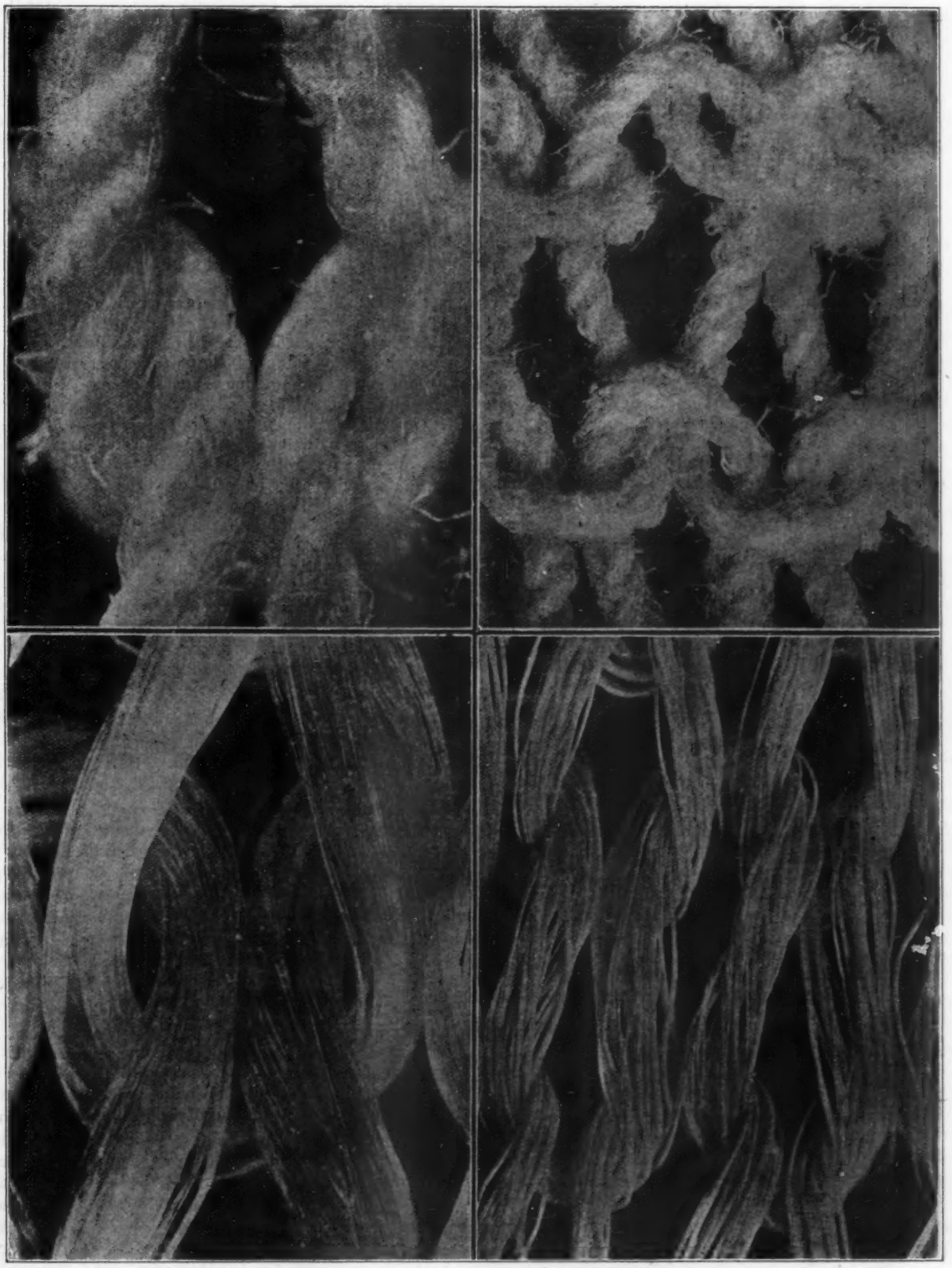
This also shows still more clearly the value of mixing the coal gas with some of the air before compression, so as to get more thorough admixture, and then using this to suck in the extra air required. Mr. Marshall found with the "Selas" high pressure system that with Berlin gas, and using a pressure of 24 inches of water, he could obtain a light of 766 candles with a consumption of 16.7 cubic feet of gas, or 45.8 candles per cubic foot. It is clear that by using lights obtained under this system over a large area, a great economy, as well as a far better illuminating effect, would be produced, as compared with half the number of lamps of double the candle power obtained by merely using gas compressed to 6 feet.

In considering the economy and utility of high pressure lighting, it must be borne in mind that although it may be politic and necessary to use what are practically blow pipes rather than burners in order to create light which in volume shall compete with the electric arc, yet up to the present the mantle has not been made that will stand such usage for any great length of time. It is claimed for the "Selas" method of lighting that the life of the mantle is enhanced by 10 per cent. instead of being shortened. If this be so, it would certainly accentuate its claim to rank before all other systems.

After all is said and done, however, the great and most important factor in incandescent lighting is the mantle. We must now turn to that portion of the subject and see what improvements have been made and what improvements are likely to be made, as upon this so much depends. Since the introduction of the present composition of 99 per cent. thoria and 1 per cent. ceria it is safe to say that no improvement has been made in the composition itself, and in this country but little improvement in the physical condition of the mantle, as although the introduction of the beautiful artificial silk processes of mantle making of Knofler, Plaissetty and Lehner showed that it was possible to obtain a very considerable increase in the life and light emissivity of the mantle, yet with the cheapening of mantles that has taken place during the past year it would not be possible for a mantle made on this principle to be sold at a price which would compete with mantles of the Welsbach type, which can be bought now at 3d. each, or even less.

In a previous course of Cantor Lectures I showed that the structure of the cotton mantle differed widely from that obtained by the various collodion processes, and that it was this alteration in structure that was mainly responsible for the increase in life. Whereas the average of a large number of Welsbach mantles tested only showed a useful life of 700 to 1,000 hours, the collodion type averaged about 1,500 hours, some mantles being burnt for an even longer period, and still giving an effective illumination. This being so, it was clear that one line of advance would be found in obtaining some material which, whilst giving a structure more nearly approaching that of the collodion mantle,

Cotton Fabric (Unburnt). Cotton Mantle (Burnt).



Lehner Mantle (Unburnt). Lehner Mantle (Burnt)

Mantle Fabrics Magnified 35 Diameters.

would at the same time be sufficiently cheap to be able to compete in the open market with the Welsbach mantle. This, I think, has now been successfully done.

By the aid of photo-micrography the structure of the mantle can be clearly defined, and on examining the Welsbach mantle before and after burning it will be noticed that the cotton thread is a closely twisted and plaited rope of myriads of minute fibers, whilst the collodion mantle is a bundle of separate filaments without plait or heavy twisting, the number of such filaments varying with the process by which it was made. Experiments showed that this latter factor has a certain influence on the useful light giving life of the mantle, as whereas the Knofler and Plaissetty mantles had an average life of about 1,500 hours, the Lehner fabric, which contains a larger number of finer collodion threads, could often be burnt continuously for over 3,000 hours, and at the end of that period gave a better light than most of the Welsbachs after as many hundred.

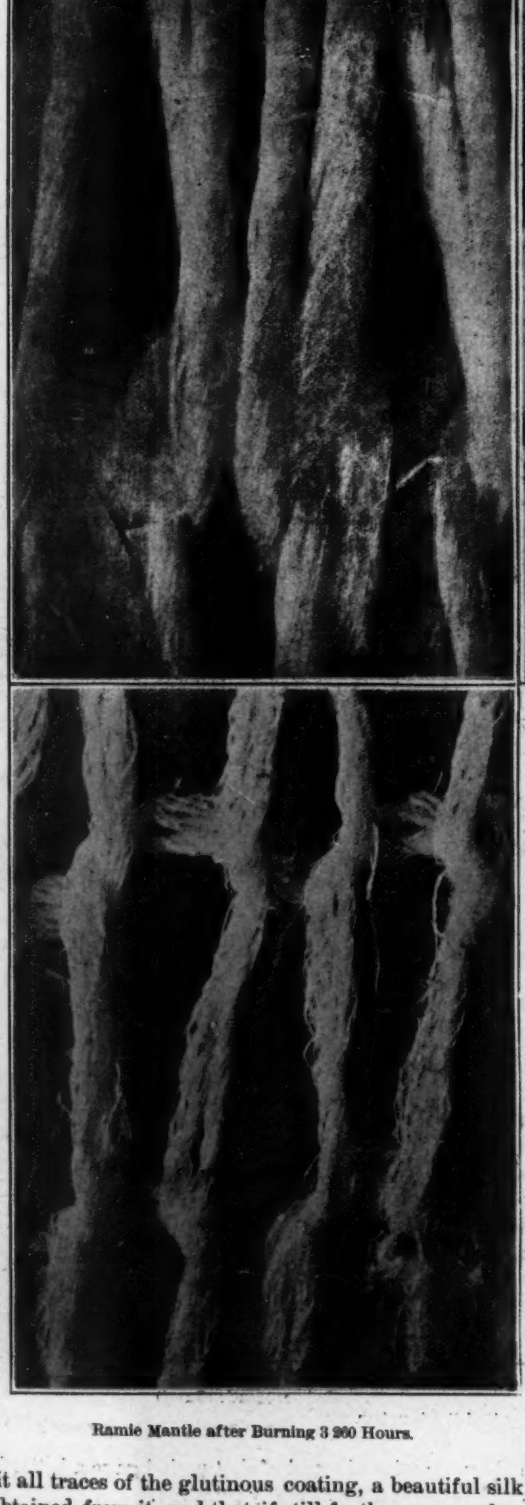
If it is known that the plaiting of the cotton candle wick gave it that power of bending over, when freed from the binding influence of the candle material and influenced by heat, that brought the tip of the wick out from the side of the flame, enabling the air to get at it and burn it away, thus removing the nuisance of having to snuff the candle, which for many centuries had rendered it a tiresome method of lighting. In the cotton mantle the tight twisting of the fiber brings this same principle of torsion into play. When the cotton fibers saturated with the nitrates of the rare metals are burnt off and the conversion into oxides takes place, as the cotton begins to burn, not only does the shrinkage of the mass throw a strain on the oxide skeleton, but the last struggle of torsion in the burning of the fiber tends towards

disintegration of the fragile mass. I think this all plays a part in making the cotton mantles inferior to their collodion brethren.

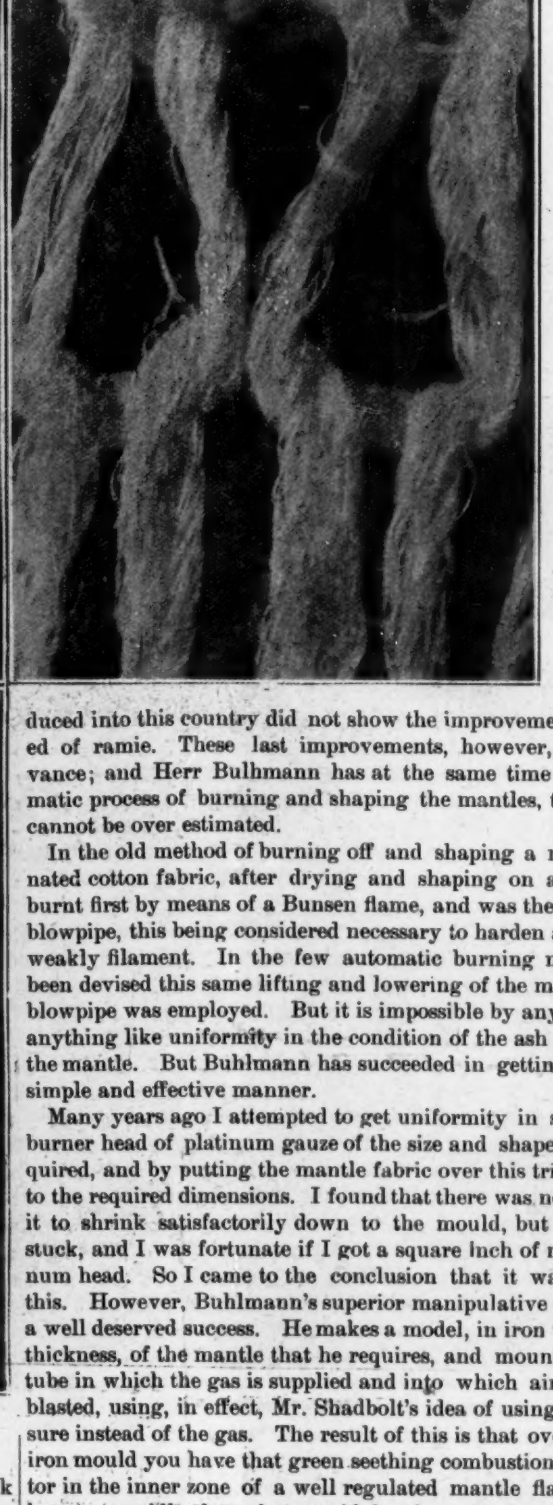
It has long been known that if ramie fiber be prepared in such a way as to remove from it all traces of the glutinous coating, a beautiful silk like fabric can be obtained from it, and that if still further prepared so as to improve its absorbent powers, ramie mantles could be made with a life considerably greater than that of the cotton fabric. It seemed that this was a likely material to work upon in finding a cheap competitor in length of endurance to the collodion mantle, and a success has now been achieved in this direction which, I think, will play as important a part in the future of incandescent lighting as any improvement that has taken place. Starting with ramie fiber and treating it in such a way as to remove all the objections which at first militated against its use for mantle making, and then making it into threads with the least possible amount of twist, Herr Buhlmann, of Berlin, has at length succeeded in making a mantle fabric superior in every way to that given by cotton. As is well known, he has employed ramie for many years in mantle manufacture, but before the later developments in treatment were arrived at the results were by no means what they should have been, and many of the ordinary "Krone" mantles introduced into this country did not show the improvement that was expected of ramie. These last improvements, however, mark a great advance; and Herr Bulhmann has at the same time invented an automatic process of burning and shaping the mantles, the effect of which cannot be over estimated.

Mantle Fabrics Magnified 35 Diameters.

Ramie Mantle (Unburnt).



Ramie Mantle (Burnt).



Ramie Mantle after Burning 3 260 Hours.

In the old method of burning off and shaping a mantle, the impregnated cotton fabric, after drying and shaping on a glass mould, was burnt first by means of a Bunsen flame, and was then shaped by a blast blowpipe, this being considered necessary to harden and strengthen the weakly filament. In the few automatic burning machines that have been devised this same lifting and lowering of the mantle over the blast blowpipe was employed. But it is impossible by any such means to get anything like uniformity in the condition of the ash or in the shape of the mantle. But Buhlmann has succeeded in getting both in the most simple and effective manner.

Many years ago I attempted to get uniformity in shape by making a burner head of platinum gauze of the size and shape of the mantle required, and by putting the mantle fabric over this tried to burn it down to the required dimensions. I found that there was no trouble in getting it to shrink satisfactorily down to the mould, but there it invariably stuck, and I was fortunate if I got a square inch of mantle off the platinum head. So I came to the conclusion that it was impossible to do this. However, Buhlmann's superior manipulative skill has led him to a well deserved success. He makes a model, in iron wire gauze of triple thickness, of the mantle that he requires, and mounts this on a burner tube in which the gas is supplied and into which air under pressure is blasted, using, in effect, Mr. Shadbolt's idea of using the air under pressure instead of the gas. The result of this is that over the whole of the iron mould you have that green seething combustion that is such a factor in the inner zone of a well regulated mantle flame, and the gas is burnt so rapidly that what would be the outer zone of an atmospheric burner flame is only a thin almost imperceptible layer above the sea-green sheath. The mantle in its unburnt condition is lowered automatically over this, a lever arm which lowers the mantle also turning on the right proportions of air and gas and starting a small sand glass. The ramie fabric burns away and the whole shrinks down until the green zone is reached, where the strong air blast that is causing this green zone prevents any further shrinkage. In the high temperature of the green zone the ash is baked and hardened for a definite period of time, marked by the running out of the sand. The burners are made up in batteries of the required number and are all actuated by the same levers, so that the mantles are all put on, burnt off, and lifted off by the movement of the lever arm. The same action that causes the lifting off

also turns off the gas and air blast. Nor is the extra burning needed to harden and strengthen the head neglected, for as soon as the mantle has shrunk to the mould the lever brings down a ring blast on the crown of the mantle, so that none of the factors of success is omitted.

It will be seen from the description that the iron gauze head of the burner shapes the inner green zone of the flame, and that this in turn shapes the mantle, so that there is no chance of adhesion between the mantle and the mould, as the two never come in contact. The result of this method of burning is to get a uniformity in size and shape and condition which it would be impossible to attain in any other way. After having examined and fully tested this method of working the mantles in Berlin, I brought two samples out of the number I had seen made back to England with me. The asbestos loop of one unfortunately got fractured in travelling, but the other I was enabled to test for endurance and light-giving power. On the ordinary Welsbach "C" burner it gave a candle power at first of only a little over 60 candles, but, to my astonishment, as week after week rolled by, the photometer indicated no decrease in the initial candle power, and for over 3,000 hours, *i.e.*, from 28th May until 10th October, when it was accidentally broken in removing a cracked glass, it continued to give a light of 60 candles for a consumption of 4 cubic feet of gas at a pressure of 12-tenths.

This result is the most extraordinary one I have ever obtained. The tests were taken every 10 days or fortnight, and the mantle had to stand the jars and jolts of being taken from the chamber in which it was burning to the photometer and back. Yet through the whole period it led a practically curveless life, and, to all appearances, had it not been for its violent end, might have gone on for a considerably longer period. The mantle so tested and giving these wonderful results contained a rather higher proportion of the oxides, *i.e.*, the ash was a rather heavier weight than the mantles in ordinary use for lighting in Berlin, which give a higher initial illuminating value of 80 to 90 candles at the start, and sink to about 72 candles after 600 hours, and then continue with but little loss of light. The result, however, shows that by this system uniformity of light as well as shape can be obtained.

I am inclined to believe that this marvellous increase in life is not altogether brought about by differences in the ramie ash, the conditions of twist in the thread, and the number of fibers present in the thread, but it is also largely due to the method of burning. When an ordinary mantle is being burnt off as is done by the Welsbach process it is shaped and seasoned, *i.e.*, blasted in a high-pressure blowpipe, and the light emitted is so intense that colored glass screens have to be used by the girls in the works. I have always felt that this high temperature treatment was a mistake, as it vitrifies and renders brittle the filament, and apparently uses up a very large proportion of the light-yielding factor in the mantle. In the automatic burning of the Buhlmann mantle, however, the fabric is quietly and gently shaped and shrunk down to the mouldhead that gives it the required size and shape, and in this operation practically no light is emitted by the oxide filaments. Yet the mantle so produced shows an elasticity and power of keeping up its illuminating value which I should never have considered possible.

On now examining the ramie fabric the great differences which exist between it and the cotton fabric are at once apparent, and it will be noticed that it approaches much more nearly to the physical condition of the collodion mantles. Dr. Killing, who has also used microscopic enlargement as a method for investigating the variations in mantles, has come to the conclusion that the cotton thread consists of about 270 single fibers, whilst the ramie thread made in this way has about 90 single fibers. The transverse section is therefore much greater with the ramie than with the cotton, and this remains, *pro rata*, the same after the impregnated material has been burned off. In other words, the ramie thread contains only one-third the number of fibers that the cotton thread does, but each fiber is three times as thick as that of the cotton, and therefore melts and is destroyed by the heat of the flame less easily than the thinner thread of oxide derived from the cotton fabric, and as the fine ash fibers from the cotton fabric fuse more easily together, the lighting power of the mantle made in this way decreases far more rapidly than that yielded by the other type. On examining the structure of the mantle which had been burned for over 3,000 hours and comparing it with the structure of a freshly burned off mantle, Dr. Killing's view is thoroughly supported, as it will be seen that each fiber remains perfectly separate, and no signs of fusion into a solid mass can be seen.

Whilst inspecting the process of burning off I took the opportunity of calibrating a large number of the mantles present in the drying room, and found an absolute uniformity in size and shape. The effect of this cannot be overrated. It is not difficult to get burners that will give a uniform shape to the flame, and with these burners and mantles made as described absolute uniformity of result can be obtained; so that instead of seeing a long street lighted by incandescent mantles, some giving an illuminating value of 100 candles, whilst others are contenting themselves with a modest 25, a uniform effect can be arrived at; and with the length of life that I have indicated an enormous advance in the position of incandescent lighting would take place.

Another direction in which the future of coal gas will benefit largely by a cheapening in price owing to economies in manufacture and distribution will be for use as a fuel. Already the ever-increasing demand made upon the metropolitan gas companies during the day marks the advance of the utilization of coal gas for cooking, heating and power. Whilst the amount of gas used at night is only rising by some 3 per cent. annually, the day consumption shows an increase of 16 per cent. Directly it becomes possible to reduce the price of the gas to about 2s. per thousand cubic feet, advance on these lines will become extremely rapid, and the gas companies are naturally doing everything in their power to foster this development. It is, however, necessary, in order to further popularize gas as a fuel, that everything that can be done should be done to remove any prejudices that exist against heating by gas.

There are many excellent gas stoves on the market, well designed and giving high heating duty for the gas consumed, but there are also many that, both in their performance and in their effect on the atmosphere, are radically bad. Now that the gas companies have so largely taken over the sale and pushing of gas heating apparatus, it is a duty they owe to themselves and to their customers to take care that only stoves of scientific construction and good efficiency should be supplied. Many of the worst stoves are the most ornate, and for that reason find their way into many houses, as they, in the first place, appeal to the eye of the housewife, and afterwards to the nose and health of the household; and the result is that a good customer is converted into an enemy of gaseous fuel. No gas fires should be sold or let on hire that do not do a large proportion of the heating by radiation, and a gas company that sells a flueless gas stove, save for hall or passage heating, should be prosecuted.

A cubic foot of coal gas on its complete combustion yields 0.52 cubic feet of carbon dioxide and 1.30 cubic feet of water vapor. If you do not mind breathing hot, polluted air, highly charged with water vapor, and getting chilled with cold walls, a Bunsen burner stood on the floor is the most effective method of getting the whole of the heat of combustion into the air of the room, and no flueless stove can do more than this. In order to get something to sell, stoves are constructed in which some of the water is condensed, and the public are gravely informed that this removes all deleterious products. But it is impossible to get away from the fact that if healthful heating is to be obtained it is the solid objects and walls of the room that must be heated, and not the air; and although some of the heat is lost thereby, a flue to take off all products is an absolute essential.

The gas companies have it in their power to really govern the gas stove trade, and unless they choose to take the initiative the popularity of heating by gas will be retarded to a most serious degree. With all stoves in which solid bodies like asbestos are heated by atmospheric burners, a trace of carbon monoxide is always produced, and if there is not a proper flue passing well into the chimney a headache is added to the other discomforts.

Improvements in gas motors and gas engines are also steadily going on, and as soon as the price of coal gas can be reduced sufficiently to attract this class of custom a wide field will be opened up for it. The development of large gas engines during the last few years gives promise of an entire revolution in our methods of procuring power, and it is highly probable that within a very few years the gas engine will make great inroads upon the generation of power by steam. Already gas engines up to 1,500-horse power have been constructed, whilst engines of over double that power are under construction. In England Messrs. Crossley Bros. and other well-known makers are producing a very large number of such engines for driving dynamos, whilst it is stated that on the Continent Messrs. Körting Bros. have made or have under construction 32 gas engines with a total of 44,500-horse power, averaging 1,390-horse power each engine; and the John Cockerill Company and several German companies follow not far behind.

With such a development of gas for motor purposes it is manifestly the policy of the gas companies to make a determined bid for so wide a field of output, and if they can supply a clean heating gas with 460 to 500 B.T.U.'s heating power, it is clear that the convenience of doing away with separate generating plant would cause a large proportion of this business to fall to their share, if the price of the coal gas could be made to compete with a fuel gas of only 150 B.T.U.'s—that is to say, if nearly the same number of calories could be obtained by its use at the same cost.

Taking this imperfect review of the possibilities of the future and the teachings of the past, what conclusions are we to draw as to the gas of the future? My own opinion is that it will be a 12-candle gas, made by mixing blue water gas with coal gas, the blue water gas being introduced either into the foul main or used as an aid to distillation, so as to do away with any need for enrichment. This gas will have a calorific value of not less than 460 B.T.U.'s net, and a selling price of not more than 2s. per 1,000 cubic feet, the economies necessary to reach this lower price being brought about by making the gas in the holder at 9d. to 9½d. per 1,000, and distributing at a considerably increased pressure, the pressure being regulated down to 1½ inches at the entrance to the consumer's meter.

Gas fittings should be entirely taken over by the gas companies, who should supply incandescent fittings and mantles, and keep them in order at a small yearly rental; and where swinging brackets and other causes demand flat flame burners, the companies should fit nipples with broad slits regulated to burn at the lowest possible pressure.

The reduction in price cannot be made at once, but as the cost of production permits, a reduction on price of gas used for fuel and power purposes should be made first, in order to expand consumption in that direction, and by leveling the load to prevent the necessity for the increase of holder accommodation at the same rate as the increase in consumption; whilst the increase in pressure will do the same thing for the mains. As time passes on the candle power of the gas may be reduced to 10 candles, and the time will then be ripe for radical changes in our methods of carbonization, which will then follow more on the lines of the coke oven illuminating gas plants now being introduced in America.

[Concluded from Page 11.]

Blast Furnace Gas Engines and Their Work.—No. III.[1]

Cockerill.—Fig. 23 shows on a somewhat small scale and in rather a bare manner the double acting tandem 4-cycle 2,500-horse power gas engine of Cockerill in Seraing. The cylinders consist of outer jackets and specially inserted boxes. The ribs of the jacket and of the cylinder rest against one another in such a way that three separate streams of water are supplied and that, therefore, the cooling of the cylinders must be very uniform and very effective. At the end of each cylinder a cylinder head is screwed on. The piston of the forward cylinder is taken out in front, while that of the rear cylinder is extracted from the rear. The result of this is that the front end of the forward cylinder and the rear head of the rear cylinder have covers, the diameter of which is somewhat larger than that of the cylinder itself. The question is whether these long covers will not burn so tight that they will be difficult to remove. The guides are placed in the frame, so that the forward cylinder cover and the piston are readily accessible. Both of the inner cylinder heads are without cover and are made in one piece. The flanges of the cylinder heads are not kept as cool as they were in the old design. The valves lie low down. Both cylinders are connected with the frame. Unfortunately, nothing beyond this can be judged from the drawing.

Deutz Double Acting 4-Cycle Engine.—The drawings, Figs. 24-27, of the Deutz 4-cycle double acting gas engine show the guides clearly, and so far as its valve motion is concerned, it is very similar to that of a steam engine. At each end of the cylinder an inlet (mixing) valve is

1. *Iron Age.*

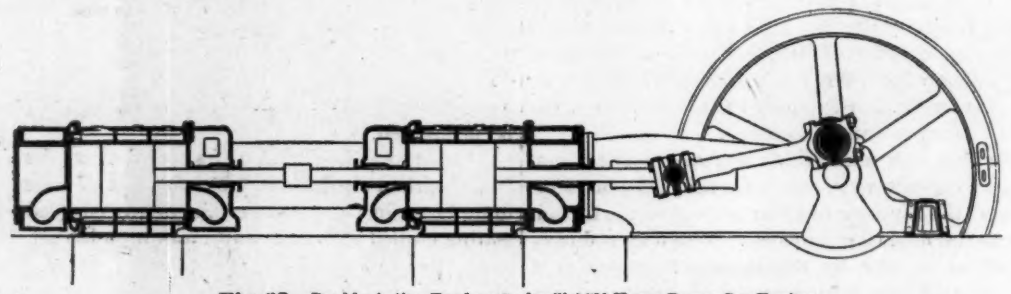


Fig. 23.—Double Acting Tandem Cockerill 2,500-Horse Power Gas Engine.

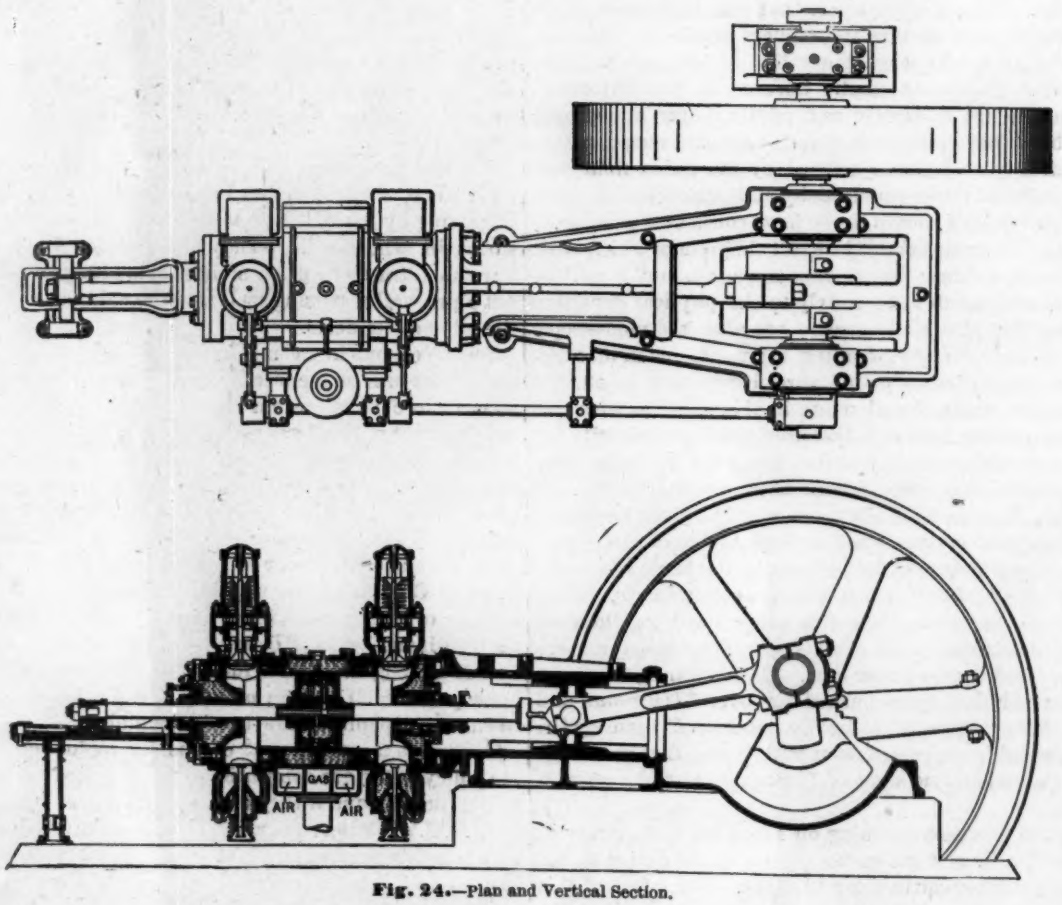


Fig. 24.—Plan and Vertical Section.
Deutz Double Acting 4-Cycle Gas Engine.

combined on one spindle with a gas valve and air valve. The exhaust valve is placed very low. The inlet valve boxes are safe, while the exhaust valve box is practically and effectively cooled, being a difficult part. The piston is water cooled. According to my idea, it should be longer and have a larger number of piston rings. After removing the back guide and a flat cover it can be taken out without touching the valve gear. An effort has been made, and is shown in Fig. 25, to relieve the pressure on the valve shaft during the lifting of the exhaust valve by the use of compressed air at the proper moment. This is also indicated in Figs. 26 and 27.

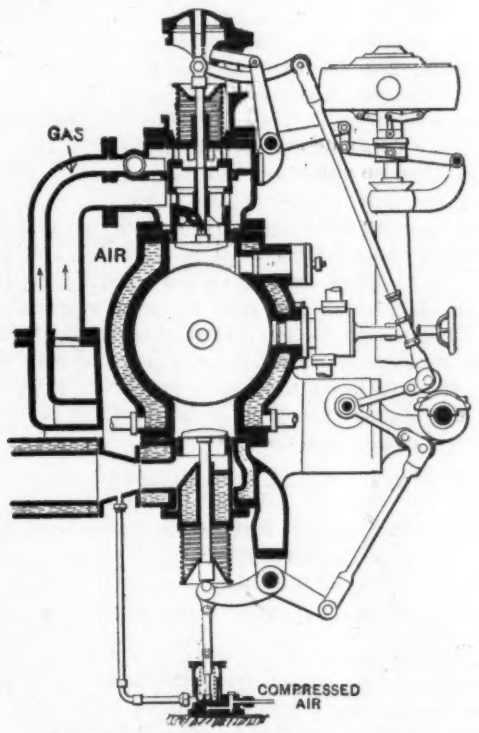


Fig. 25.—Section Through Cylinder Head.

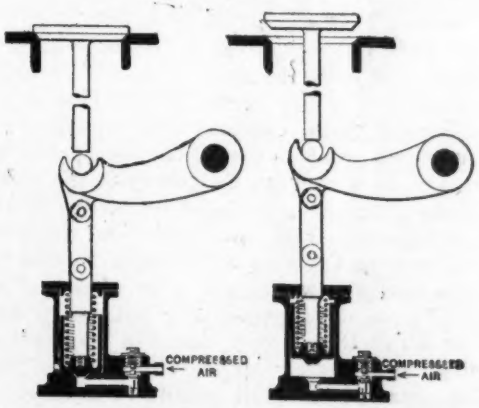


Fig. 26.—Position of Valve Closed.

Fig. 27.—Position of Valve Open.

Device for Relieving Exhaust Valve.

Deutz 4-Cycle Double Acting Gas Engine.

As compared with the ordinary 4-cycle engines these double acting motors have the advantage of greater regularity in running and of small size for equal power. Compared with the double acting 2-cycle motors they are larger in their dimensions, have a less uniformity of running, but a higher mechanical efficiency. Besides this there is the disadvantage that exhaust valves are necessary and that these lie below the piston rod. I desire to point out that all the modern gears depending upon regulating by quantity and by changeable compression possess the drawback that the valve mechanism does not operate quietly when the engine is under light load or under no load at all.

It will be observed that there is a very much larger selection of gas engine systems than ever before, and that it will become even more difficult to reach a decision in the near future. The main question which obtrudes itself is, which system is most satisfactory? Unfortunately this question cannot be answered off hand. It depends above all things upon the size of the engine, the purpose to which it is put and the price to be paid. The consumption of gas will probably not play that part which it does when running with producer gas, in which fuel causes direct outlays. Besides, it is only a question of differences of 10 to 20 per cent. So far as the modern valve gears are concerned, experience is either inadequate or is lacking altogether. The consumption of oil has been much reduced in the large engines. Many of the figures submitted to me seem so low that I hesitate to reproduce them. The consumption of cooling water for the engine alone is given at 40 to 80 liters per hour per horse power.

An answer to the question propounded can only be very general in its character, and according to my sincere conviction I will answer it as follows: For smaller engines, from about 300 to 400-horse power, I would give the preference to the open double acting 4-cycle engine, provided it has adequate guides and a cylinder head design proven by prolonged practical experience. As it seems to me, the cylinder heads on an average have not proven absolutely safe in practice with the larger cylinders. Besides this, there is the disadvantage of the large exhaust valve and the strains upon the valve shaft in lifting the valve. For larger powers, therefore, those designs seem to me the most suitable which possess the smallest dimensions as to cylinder heads and valves. This is the case with the double acting 4-cycle engines and with 2-cycle engines with or without cylinder heads. For very large powers, about 1,000-horse power in one cylinder, I would choose to-day only those engines which have no exhaust valve; in other words, 2-cycle engines.

The Petroleum Industry of California in 1902.

A special correspondent of the *Engineering and Mining Journal* contributes the following complete article on this subject to its special number, dated the 3d inst.:

Though the consumption of oil increased greatly in 1902 the petroleum industry of California throughout the past year has been in a condition of great depression from the standpoint of both the oil producer and speculator in oil stocks. However, there has been remarkable development in transportation and consumption with every promise of still greater development during 1903. The oil industry is now recognized as a very important element in the rapid industrial and commercial growth of the State of California and of the whole Pacific region.

The year 1901 was characterized by a speculative boom and a great increase in production, the actual output reaching 7,710,315 barrels—an increase which vastly exceeded the consuming capacity of the market as then developed. The inevitable reaction came near the end of the year, when it was realized that the producing wells then drilled were able to supply more than double the amount of oil for which there was a market. There was a sudden end to the boom in oil stocks, and during 1902 investments were made mainly by large capital along legitimate lines. During the last 9 months of 1901 there were 2,951,660 shares of oil stocks of a selling value of $1,487,424 traded at the Producers' Oil Exchange in San Francisco, while the record for 1902 shows but a small fraction of this amount.

The year thus opened with a supply of perhaps 15,000,000 barrels a year in sight, from over 2,400 producing wells. The existing refineries have provided a sustained market for light refining oils, but the heavy asphaltic fuel oil of the Kern County and Los Angeles fields constitutes the great bulk of the output, and early in the year Kern oil, which pays 40 cents for transportation to market, began selling for 10 to 15 cents at the wells. These prices have ruled until recently. A few months ago Los Angeles oil dropped to 35 cents at the wells, but its price has been about 60 cents most of the year. The low prices and the glut of oil caused the capping of many wells, the number of capped wells on May 1 being over 500. There are now in the State 2,500 productive wells, of which several hundred are capped.

Drilling fell off greatly during the year, and new developments have been mainly in the search for light oils, resulting in the development of two new fields of this character. One is the Santa Maria, in Santa Barbara county, in which the Western Union Oil Company has brought in 10 deep wells, yielding a valuable light gravity oil and advantageously situated for piping to the coast. A nine-tenths interest in this property recently sold for $1,425,000. In the Halfmoon Bay field close to the sea and 35 miles from San Francisco, productive wells have been developed, and the field promises to be important. The product is a good refining oil of 45° to 52° gravity, and a small refinery is in operation. The search for light oils continues elsewhere in the State. The important Coalinga field in Fresno county, the product of which is largely a light oil, has maintained an even status, though still handicapped by lack of transportation facilities.

The year has been mainly given over to the rapid development of means for the transportation, storage, refining, consumption, etc., of the great supply, already developed. Most significant are the operations of the Standard Oil Company, which has been investing several millions

in tanks, in its 278-mile pipe line from the Kern fields to San Francisco Bay, and in its great new refinery at Point Richmond. The company believes it has solved the problem of piping the heavy Kern oils with an 8-inch pipe line and 10 pumping stations. The line will be in operation within 6 months, with an initial capacity of 10,000 barrels a day. Recently the company contracted with the Peerless Oil Company for 5,000 barrels of Kern River oil a day for 5 years, and it has made other large contracts. The company will pipe only its own oil for refining and for direct sale for fuel, but the pipe line will release many tank cars for other shippers.

The increased use of oil for fuel, is, of course, the great feature of the year. The consumption in this direction has been mainly by the railroads, and in the San Francisco Bay region, which has been enjoying great industrial expansion. In the city of San Francisco 200 power users have secured permits to store and burn crude petroleum, and many of the large industrial plants of the bay region have also adopted it. Coal for steam raising has cost about $6 per ton, while oil cuts this in half. Imports of coal have been reduced about 50 per cent. Oil, however, has a new competitor in the electrical energy now brought 200 miles from the Sierras.

The Southern Pacific, the Santa Fe and the minor railroad systems have been altering their locomotives to use oil fuel. The Southern Pacific now has 504 engines burning California petroleum, and is adding others as fast as possible. At the average consumption of 600 barrels per engine per month, this company is now using 3,600,000 barrels per year. Throughout its system it is erecting storage tanks to hold a 6 months' supply. On all roads running in and from California about 1,000 locomotives are now using oil at the rate of between 6,500,000 and 7,000,000 barrels per year, or nearly the output of 1901, and this consumption will largely increase during 1903.

One of the most striking and promising developments of the year has been the adoption of oil fuel for marine boilers. The Federal authorities have granted 105 permits to vessels of all classes with a total tonnage of over 90,000. The vessels are mainly bay, river and coasting craft, but the *Enterprise*, of the Watson Navigation Company, in April made a successful run to Honolulu and return with oil fuel. In July the *Mariposa*, of the Oceanic line, 3,180 tons, made a long trip with oil fuel to Tahiti. Lieut. Ward Winchell, of the Navy, accompanied the vessel, and his report of complete success greatly stimulated the use of petroleum in Pacific waters. During recent months several ocean-going steamers have become oil burners, and more soon will be. Next season oil fuel will be used on the Yukon River steamers of the Northern Commercial Company. During the year 7 oil transports have been put into operation to and from San Francisco, making 9 altogether, with capacities of from 6,000 to 30,000 barrels. More are to be provided soon.

In this connection the recent explosion of an oil tank in the steamer *Progreso*, which was being made into an oil transport for the Atlantic trade, at San Francisco, is important. The explosion was evidently caused by the ignition of gas generated in a nearly empty tank. It destroyed the steamer and killed 14 persons. The oil was a mixture of light and heavy, with a low flash test, and the tank was not properly ventilated. It is not thought that the disaster will retard the marine use of oil, but that it will lead to proper precautions for safe storage and use.

The shipment of California fuel oil for Hawaii and Puget Sound and other coast districts is rapidly increasing. The Standard Oil Company is erecting large storage tanks at Tacoma, and many will be erected elsewhere. During the year storage for several millions of barrels has been provided in the fields and at points of consumption.

The number of oil refineries has increased from 11 in 1901 to 33, and soon several million barrels per year will be refined. The new refinery of the Standard Oil Company will, it is stated, be the second largest in the United States. Other refineries, some of large capacity, have been erected near San Francisco and Los Angeles, and in San Joaquin Valley. The heavier oils, as well as the lighter, are being treated, and the increase in the production of asphalt, a residuum of the heavy oil, is rapid. A small percentage of illuminating oil is one of the products of distillation at some plants, but its poor quality requires mixing with Eastern petroleum, and until a supply of paraffine oil is developed this product will be of minor importance in California.

The Selby Smelting Works on San Francisco Bay now uses crude oil in 47 roasting and reverberatory furnaces, with a fuel saving of 50 per cent. It is also used in the Shasta county copper smelters. The problem of its use in blast furnaces continues to excite local interest.

In the above and other ways the consumption of the California petroleum probably amounted to 12,000,000 barrels in 1902, according to the estimates of Secretary C. T. Deane, of the California Petroleum Miners' Association, and may easily reach 20,000,000 barrels in 1903. The consumer has thus nearly overtaken the producer. Within a month there has been a noticeable stiffening of prices of oil stocks and of oil prices. Within a few weeks oil has sold at the wells in the Kern River field at 25 cents or more per barrel, in spite of the enormous productive capacity of the field, and better prices are expected throughout 1903. The Southern Pacific Railroad Company has ordered 600 new tank cars of large capacity, and with about 2,500 cars in use in the State and the completion of the Standard's pipe line, the marketing of the product will be facilitated greatly.

One of the events of 1902 was the organization of the Associated Oil Company by the combination of about 30 producing companies of the Kern county fields. The future of the combination and its relations to the Standard Oil Company are matters of speculation. It has talked of an independent pipe line, and it has authorized an issue of $5,000,000 in bonds. The Union Oil Company, next to the Standard the largest producing and refining company, in the State, has invested largely in Kern fields and erected a refinery at Bakersfield.

Various large projects have been talked about, but remain inchoate. One is a railroad from the Kern fields to the Coast, and another is a pipe line from the Coalinga field across the Coast Range, 125 miles, to the Coast. W. H. H. Hart has been for some months promoting a syndicate of Eastern and foreign investors with $10,000,000 capital to acquire extensive Kern properties, build a large refinery on the bay, make coke for smelting iron and manufacture steel. It has not reached the stage of operations. An effort to combine the companies of the Summerland field has so far failed.

Electrical Distribution of Power in Industrial Establishments.[1]

By Mr. Cecil P. Poole.

When this journal came into existence 25 years ago, there was not one electric motor in commercial use in this country and probably not in any other. To-day the number of motors in industrial establishments is so great and increasing so rapidly that it would be impossible to obtain a census of them that would be accurate when the labor of collating and digesting reports would be concluded.

The use of motors in factories, mills, etc., began in a really comprehensive way about 1889, when the works of the old Thomson-Houston Company (since absorbed by the General Electric Company) and those of the C. & C. Electric Motor Company were equipped with motors driving short line shafts to which were belted the machine tools of the works. Later on in the same year, the factory of the Globe Tobacco Company, at Detroit, Mich., was equipped similarly. In 1893 several of the textile manufactories took up the question, and a few motors were put in to drive certain sections of the plants. A year or so later, one of the representative New England print works put in a motor equipment, and this was almost immediately followed by the introduction of polyphase (alternating current) motors in the now famous Taftville textile mills. It is scarcely necessary to point out that there is now not a solitary class of industrial machinery to which the electric motor has not been applied, and with a degree of success limited only by the skillfulness with which the application has been made.

In the early days of electric power, some fantastic methods of motor speed control were put forth, with the result that a reaction soon took place, and the simple shunt-wound motor reigned supreme for several years. Largely on this account, but partially because of the natural inertia of industrial plant managers with regard to radical innovations, the application of electric motors in manufacturing plants was for some time restricted to one shunt-wound motor in each department of the plant, the motor driving a line shaft from which the various machines of that department were belted. Within the past 3 or 4 years, however, confidence in the practicability of multiple speed motors has been fully restored by reason of the development of several worthy systems of speed control. As a consequence, it is now the frequent practice to drive every machine of appreciable size by means of an individual motor built, when the service demands it, for several speeds.

It may be remarked, just here, that the use of individual motors bids fair to be as badly overdone in the immediate future as it was neglected or spurned in the past. It is seldom the case that individual motors smaller than 3-horse power can be used profitably, and in by far the larger number of cases 5-horse power is about the economical limit in the downward direction. As a rule, it will pay better to run a 5-horse

1. *Engineering Record.*

power motor continuously below full load than to operate one of two smaller machines fairly continuously and the other one spasmodically, for the reason that the excess of fixed charges on the two smaller machines over those on the single larger one will cost much more than than the excess in their running economy will save. It is obvious, however, that when locating a single machine at a place remote from others with which it might have been grouped will effect a considerable economy in labor or a considerable increase in output, than it will pay to isolate it and drive it with an individual motor; the cost of power, at the worst, being a relatively small proportion of the total operating expense. No generalization can be made, however, that will draw a line with any accuracy; the question of subdivision of power must be intelligently figured out in every case to fit that case.

Concerning the economy obtainable by the use of electric motors as compared with shafting and belting, there is no longer any room for argument in cases, such as machine shops, where some of the machinery is always idle. In a machine shop driven by a single engine through belts and shafting, the latter use up from 60 to 80 per cent. of the total power developed by the engine. Motor driven shops, on the other hand, will easily show a conversion and transmission efficiency, from engine to machine tool, of 65 to 70 per cent. (loss of 30 to 35 per cent.), when the dynamo is running lightly loaded, and from 75 to 80 per cent. when things are in full operation. The chief merit of the electric motor in factories, mills, etc., however, does not lie in the greater economy of power obtainable, but in the superior ease of operation and regulation, by means of which a much greater output from a given machine is rendered practicable. The present writer knows of one case in which the application of electric motors made it possible to increase the output per man and machine to such an extent as to reduce the cost of the product nearly 30 per cent. Beside such a result, a saving of 40 to 50 per cent. of the power consumption dwindles to insignificance.

Reverting to the question of speed control; there are in wide use today three fundamental methods, two of which are nearly always combined, and sometimes all three. One consists of varying the field strength of the motor; another (seldom if ever used alone) is the provision of two windings and commutators on a single armature, which may be connected in series for low speeds and in multiple for high ones; the third consists of providing a plurality of supply circuits each of a different voltage and all interlinked so that the voltages may be added, the motor armature being connected across whichever of the supply circuits will produce the proper speed.

It is usual to combine the first method with one of the others, and the best results are obtained by such combination. For example, a double commutator motor with finely graduated field regulation can be brought from full speed down, in almost imperceptible increments, to half speed with the commutators in multiple; then throwing the commutators in series and the field regulator back to the full speed position simultaneously, the motor will continue at exactly half speed, from which it may be reduced gradually to minimum speed by repeating the manipulation of the field regulator. In practice the simultaneous shifting of commutator relations and changing of field strength are performed by a controller requiring the manipulation of but one handle. This method has the merit of maintaining the full power of the motor, down to the lowest speed, the "torque" or turning effort of the armature being increased at the same rate at which the speed is decreased. It has the disadvantage of reducing the efficiency of the motor somewhat at lower speeds, but this is of no moment practically.

The multivoltage system, combined with field regulation, is the most flexible of all methods of speed control thus far devised for direct current work. As usually installed, there are three circuit wires, the voltage between No. 1 and No. 2 being, say, 80 volts, and the over-all voltage (between Nos. 1 and 3) being 240 volts. This gives a pressure of 160 volts between wires Nos. 2 and 3, so that there are three voltages available, and consequently three ranges of speed each graded by means of the field regulation. Thus, a motor running at a maximum speed of 1,200 revolutions per minute, and having field regulation of 30 per cent., may be operated at from 280 to 400 revolutions per minute on one pair of wires, 560 to 800 revolutions per minute on the next pair of wires (Nos. 2 and 3), and 840 to 1,200 revolutions per minute on the outer wires, Nos. 1 and 3. With this system the motor can develop its full power only on the highest voltage; a motor that will develop 10-horse power on the outer wires can develop only 6⅔-horse power on the 160-volt pair and 3⅓-horse power on the 80-volt pair of wires. Inasmuch as the power required of a stationary motor under most conditions is substantially proportional to the speed of the driven apparatus or machinery, this falling off in power at lower speeds is not often a disadvantage.

For establishments in which the driven machinery must run continuously at a rigidly constant speed, the synchronous alternating current motor is an ideal driver. So long as the generator that supplies current to the motors is driven at a constant speed, the motors themselves will maintain an absolutely constant speed regardless of load or voltage fluctuations, unless they are greatly overloaded, in which event they will "break down" and come to a standstill. The term "break down" when used in this sense refers merely to the motion of the machine, and does not imply mechanical or electrical disaster. The break down load point of a good synchronous motor is sufficiently beyond its full load point to constitute no disadvantage whatever when the motor is operated under the condition for which it is best suited—a steady load.

The induction type of alternating current motor, in its behavior, is a cross between the direct current shunt-wound motor and the alternating current synchronous motor. Like the direct current machine, its speed drops as the load increases; like the synchronous machine, its speed bears a definite relation to the speed of the supply generator and does not vary with the circuit voltage. Also like the synchronous motor, it has a "break down" point at which it refuses to carry the overload and comes to a dead halt; both machines, moreover, are not susceptible of practical speed control. In industrial plants where a motor can be operated with reasonable continuity and under a fair approach to full load, the induction motor is capable of excellent service; but there is not a set of conditions under which it has any real superiority over the direct current motor except in a powder mill or other place where the air is likely to be full of explosive particles susceptible of ignition from the least spark, such as the impurities in a carbon brush are likely to produce at the commutator of any direct current motor.

For intermittent service, requiring frequent starts under load, or even without load for that matter, the induction motor cannot compare with its direct current mate, while for multiple speed operation it is absolutely impractical so far. In order that the alternating current system may be placed on an equal footing with direct current for power distribution within manufacturing plants, or over limited and congested areas, it is essential that an alternating current motor shall be produced that can be operated at several speeds, started under load from standstill without taking excessive current, and operate at all loads with a power factor at least approaching unity. The last two requirements are not nearly of so great importance as the first one. The chief disadvantage of the alternating current motor now is the total lack of speed gradation, but it is not too much to hope that this obstacle may eventually be overcome.

The Interest of the Gas Industry in the Measurement of Illumination.[1]

A subject of great and growing importance to the gas industry is suggested by Dr. Krüss's communication on the "Measurement of Illumination," of which we give an abstract translation from our German contemporary, the *Journal für Gasbeleuchtung*. Hitherto this branch of photometry has not received much attention at the hands of gas engineers; but with increasing severity of competition with other illuminants it is desirable that the study of the most effective utilization of gas for lighting and the measurement of illumination should be taken up—not only as a weapon of defence to enable our illuminant to hold its own, but also as a means by which it may be enabled to advance still further in public appreciation and usefulness. Besides, if illuminating power, as ordinarily determined, is to retire into the background as a measure of the value of the gas for illumination (as seems to be the prevailing opinion), the actual measurement of illumination, in concrete examples, must acquire increasing interest and importance.

Even before the new era inaugurated by Welsbach's invention, the measurement of illuminating power and the measurement of illumination were not by any means terms synonymous in meaning or import. The object of official photometry is to determine potentiality of illumination, under certain narrow and rigidly defined conditions, which are not always, nor often, the same as occur in practical lighting. For example, the 16-candle flame of the standard Argand, when applied to ordinary room illumination, is found to be not nearly so effective as the normal 12-candle flat flame. This is so still more emphatically if the latter light be inclosed in a diffusing globe. The reason is obvious. The Argand gives out its highest luminous effect in the horizontal direction, in which it is estimated by the photometer, whereas the flat

1. The *Gas World*.

flame emits a greater proportion of its luminosity in the downward direction, where it is most needed for ordinary lighting. Of course, this peculiarity did not detract from the utility of the photometrical test when ordinary flames were the usual illuminants, seeing that the object of that test was to determine the relative potentiality of illumination; and therefore its indications were good for comparative purposes. With the spread of incandescent lighting, however, a new order of things has arisen; and the determination of illuminating power with the standard burner now bears no direct, nor clearly understood indirect, relation to the illuminating effect which the consumer may obtain with the means at his disposal. It is this consideration which is leading the master minds of the gas profession to set less store by standards of illuminating power and to attach greater weight to questions of cheapness of supply and the plentiful provision of efficient burners and cheap mantles and other lighting appliances.

This leads us to remark that we shall welcome the growth among gas engineers of a practical interest in the measurement of illumination as a further indication that the suppliers of gas are paying more heed to actual requirements, and giving more assistance to the endeavors of consumers to burn gas with efficiency and economy. In the old days of autocratic administration of gas undertakings it was thought sufficient if the consumer was supplied with gas of the statutory illuminating power. Nowadays, with a clearer perception of the true interests of the undertaking, the needs of the consumer are being studied and supplied—as, for example, in the provision for maintenance of incandescent burners.

There is a new field for usefulness in the measurement of the illumination of gas lighted interiors, and in the setting up of standards of illumination with the view of showing the consumer how gas lighting may be most effectively and economically carried out. At present, and speaking generally, the provision of gas lights follows no predetermined lines, is guided by no fixed rules. The consumer, left to his own devices, selects perhaps something brilliant and of pretty appearance, with the result that often there is abundant illuminating power with very unsatisfactory illuminating effect. For it is not sufficiently recognized that satisfactory lighting is not so much a matter of powerful light sources as of the proper disposition of only moderately powerful ones. After all, illumination is a physiological fact, and the eye is prejudicially affected more by contrast than by mere deficiency in quantity of light; so that a room containing brilliant centers of illumination alternating with comparatively dark patches is not so pleasing as one lighted by a much smaller total illuminating power, but without glaring contrasts. What is needed, therefore, is that the officers of gas undertakings should study the question of effective lighting both practically and theoretically, so as to be enabled to show the public, by argument and illustration, how to get the best effect from gas as an illuminant.

To this end the illumination photometer must be brought into more extended use, and we are glad to see that it is the subject of a paper to be read by Mr. Fowler, of Derby, at the next meeting of the Manchester District Institution of Gas Engineers. Whether the particular form of the instrument which Dr. Krüss illustrates and describes is the best that can be advised, time and experience of its working must decide. The choice is not limited to that. There are several arrangements available, differing in details of construction, but designed for the same end; one of the most recent, and apparently among the simplest, being due to Messrs. Simmance and Abady. The feature of Krüss's instrument of which we should be most doubtful is the standard of light employed; and we must confess to a preference for the simplicity of the Bunsen disk, for the observation of the compared lights, rather than the optical train which he has adapted from Weber's and Lummer-Brodhun's photometers.

The Progress of Electrical Science During the Year 1902.

By Mr. A. E. Kennelly, in *Elec. World.*

The year 1902 has witnessed great development in electric science and in its applications. As a result of experimental research, the ionic hypothesis has steadily gained ground. According to this hypothesis, all electrifications are due to the presence of free or unsatisfied electric charges on atomic masses, in which atomic masses electric charge permanently and inherently resides as a fundamental physical property. Some atomic masses are essentially positive, others essentially negative. The union of the two is atomic combination and accompanies chemical combination. Their disunion effects electrification. Similarly, all electric discharges in fluids and conductive electric currents in solids or liquids are referred, on this hypothesis, to ionic movements in the conducting mass.

As a development of the ionic theory, the corpuscular theory of J. J. Thomson also appears to have gained ground from the experimental research of the past year. On this hypothesis, negative ions are corpuscles, or quantities of matter much smaller than atoms; while positive ions are atoms denuded, or deprived of, corpuscles. A body, which becomes negatively electrified without any other change in condition, is a body which has gained in mass by the addition of corpuscles; but the actual addition in mass would be regarded as so excessively minute as to evade all experimental observation.

According to this hypothesis, the fundamental nature of electricity, not yet determined, is essentially enrolled with the fundamental properties of every chip of matter of which each atom is built.

A large amount of research has been conducted in radiography and radio activity. This science practically owes its existence to the experiments by which Röntgen x-rays were discovered. Radio activity is a branch of physical chemistry, and, on the corpuscular theory, involves sub-atomic chemistry.

In electro chemistry much research has been carried on, mainly in connection with practical applications. In fact, the industrial demand for application of electrical energy to electro-chemistry may be said to have created the demand for the application of intellectual energy to the study of that science. A large number of new electro chemical processes have been devised, and some have already been put into operation. In Nature, chemical change is the sequel of local superabundance of energy, and the art of industrial chemistry naturally develops where energy is cheap and abundant. With the aid of engineering, waterfalls are becoming hives of electro chemical industry.

A process has already been initiated for electro chemically producing nitric acid from air, and hence the nitrates which enter into the development of food products. Perhaps this is the furthest existing attempt in the direction of artificial food production by electro chemical means. Food may be regarded as assimilative substance produced by solar energy acting on non-assimilative substance. Each inland human being needs, on the average, a certain considerable area of soil upon which the solar energy machine can work, during the year, for the production of the food products that he consumes either directly or indirectly through the consumption of some other animal that he finally consumes. The solar energy costs nothing, but the engine in the form of the recipient soil, plants, agriculture, transportation, etc., has very definite expense. The same amount of annual incident solar energy would be enormously expensive to produce artificially; but so inefficient is the solar energy from a pure food production viewpoint; that is to say, so little of the incident solar energy is actually utilized in the food engine, that if we only knew how to accomplish the same result simply and conveniently, the necessary energy could probably be delivered to the raw material artificially, at lower final cost than that which agriculture and transportation involve. Nevertheless, the solution of the artificial food problem appears so remote that we must remain content with our thousands of square miles of solar food engine and our millions of peripatetic food storing quadrupeds. Every new fact and application of electro chemistry, or energy chemistry, may, perhaps, bring us nearer to an ultimate solution of the problem.

Some discussion still continues as to whether a moving electric charge does create a magnetic field in its vicinity. The phenomenon should occur according to orthodox electro magnetic theory. It is claimed to have been observed by various physicists. It is claimed, on the other hand, not to have been observed, by a few. The weight of the evidence seems to be in favor of the fact. By the same token, the converse proposition should follow, that a moving magnet creates an electric field. This phenomenon does not appear to have been yet recognized.

In the treatment and expression of alternating current theory, complex quantities, and their geometrical substitutes—plane vectors—have continued to make headway in general appreciation. The algebra of the complex quantity is, *par excellence*, the natural and simple algebra of the alternating current circuit. If it be discarded, simplicity vanishes and complexity reigns supreme.

Although a great number of direct current generators and motors have been built and installed during the past year, yet the direction of most rapid advance has been in connection with alternating current machinery. Pressures are rising steadily, and as the pressure rises, the distance within the vision of supply increases, so that, when the price of fuel in a city is sufficiently high, power can be transmitted thither electrically from falling water at distances that have hitherto been impracticably great. The existing commercial limit is now set in California at 220 miles with 60 kilovolts, and the final limits are not yet

encountered. This application of electricity is turning much attention to the study of commercial forms of insulators. The cost of insulation per mile of high pressure circuit comes into appreciation, together with the cost of conductors and conduction. In a certain sense it may be already said that the range of economical transmission used to be set by the cost of conduction; but now begins to be set by the cost of insulation. Whereas, however, the art of conduction has reached scientific limits that for the present cannot be overstepped, so much conductance calling for so much investment, according to stereotyped rules, the art of high pressure insulation is much younger, and has not yet apparently reached any definite limit.

In steam power transmission by electricity the advent of the steam turbine has created some stir during the past year. When harnessed to the steam turbine the alternator visibly shrinks in dimensions. Already large sizes of stationary steam turbines are being constructed, and if their performance is as good as their projectors anticipate, we may look for a revolution in central station steam engine construction.

In electric railways great development has taken place along the standard American lines of the 500-volt, direct current system. Efforts have been made to break through the monopoly which practice has established for the direct current system in this direction and to introduce the alternating current, long distanee, high speed railroad motor. The great advantage of such a step, if successful, will be the suppression of the converter sub-stations. The exigencies of long distance, high speed railway traffic are such that nothing should revolve save the prime generator at the central station and the motor and wheels on the cars. The cost of equipping and maintaining adequate converter substations heavily handicaps the long distance electric railway.

While the alternating current motor has been striving to obtain a foothold in railway work, improvements have been made in the induction motor, whereby its power factor has been increased and its magnetism has become capable of being produced locally, instead of being produced by dephased alternating currents sent over the transmission lines all the way from the generating station. How fully this advantage can be practically secured yet remains for the future to determine; but there can be no doubt that if the wattless component of currents supplied to induction motors can be conveniently eliminated the result will be a marked gain in alternating current distribution. It should be no business of the transmission lines to carry the existing currents of the motors. They should only carry the energy of excitation.

An interesting and significant feature of the times is that the sciences, physics and chemistry on the one hand, and electrical engineering on the other, are growing closer. Engineering depends every day more closely upon these sciences, whence it draws its supplies. On the other hand, physics and physical chemistry are being daily more fully applied to the arts of life under the title of engineering. Consequently the enormous national, industrial and commercial importance of these sciences is becoming more closely apparent year by year.

The past year has seen the National Bureau of standards placed upon a firm foundation. This important bureau is destined to form yet another connecting link between science and its applications, electrical, chemical and mechanical.

The metric system has made considerable headway towards public favor during the past year, not only in America, but also in English speaking countries. The younger generation, and progressive men everywhere, are for introducing it into general use, as soon as public welfare will permit. In this country, the Congress Committee on Coinage, Weights and Measures has strongly recommended a bill for adopting the system, and the Conference of British Colonies has also recently adopted a resolution in favor of the system for all British colonies. Leading men in Great Britain have recently expressed similar sentiments. Under these circumstances we may reasonably hope for such joint action among English speaking peoples, in the near future, as will discharge the present incubus of a shamefully unscientific medley in weights and measures, for the simple metric system that has been found to give great satisfaction to European countries. The metric system lessens national labor, dispels fog and assists civilization.

The year 1902 will be notable in electric annals, if only for the reason that it has first seen the electric girdle completed around the world by the successful laying of the Pacific cable. The task has taken practically half a century to accomplish; since the first submarine cable for commercial work was across the Straits of Dover, in 1851. The latest cable in the Pacific, from Vancouver to Fanning Island, is the longest and the deepest cable in the world.

The terrible disaster of the 8th of May last, at St. Pierre, Martinique, is perhaps without a parallel in history. The suddenness with which the city's population was asphyxiated by hot volcanic gases was the appalling feature that stands unique on our records. The disaster made itself felt in electrical circles by the destruction of the cable ship *Grappler* in the roadstead at St. Pierre, and by the breaking of 6 submarine cables in the neighborhood of the volcano.

The year has also seen the feat of sending messages, by Hertzian waves, over and across the Atlantic, and from Cornwall to Cronstadt on the north and to Gibraltar, Cagliari and Genoa, in the Mediterranean. Even although no industrial use were to be made in the near future of these long distance messages, yet their achievement is something that will always signalize the year. Wireless telegraphy has made much progress during 1902. Many vessels have become equipped with the apparatus, and various shore stations have adopted the system along the coasts. It seems to be only a question of time when all large vessels will be able to communicate by wireless telegraphy, with lightships and lighthouses throughout the world.

Telephony has made marked progress during the year, and continues to ramify its connections deeper and deeper into the shops, offices and residences of the people. The telephone is becoming ubiquitous, and the saving of time to the community which is thus afforded is enormous, expressed either in money, hours or convenience. Long distance telephone lines are being cheapened in construction by diminishing the size and weight of conductor, while adding reactive loads, or inserting reactances at regular intervals. Telephone engineering touches the sciences at many points, and makes great demands upon knowledge and skill.

Fortunate it is that as telephone circuits multiply, they do not tend to obtrude themselves more noticeably on the landscape. In the open country the wires certainly become more numerous and spread overhead upon poles; but in urban and suburban districts the more wires there are the cheaper it is, per wire, to bury them underground. Long distance transmission tends, of course, to suffer thereby, even when the circuits are loaded; but the average service is far better and securer against wind and weather with underground than with overhead wires.

Subsequent to the welcome cessation of hostilities in South Africa, practically all the forces of engineering have been devoted during the year to the amelioration of the world and the uplifting of human existence. In this beneficent joint work the share of the electrical sciences and arts has been an important one. It means in the United States the daily occupation of more than half a million of workers.

The Rapid Determination of Carbon by Combustion.

By GEORGE AUCHY, in *Jour. Am. Chem. Soc.*

Some experiences with the dry method of combustion having led the writer to the suspicion that the employment of a rapid rate of gas flow is occasionally attended with loss on account of incomplete oxidation by the copper oxide of the products of ignition and combustion, it was thought that it might be advantageous to use the Shimer apparatus with the modification of having the copper oxide in the crucible instead of in a tube.

In this plan the products of combustion are not forced through the copper oxide by the current of oxygen, but are carried in through the apparatus by the current of oxygen *after* oxidation by the copper oxide has been effected. Therefore, the time of contact with the copper oxide is entirely independent of the rate of gas flow employed, and the carbon compounds will be just as thoroughly oxidized by the copper oxide with a fast as with a slow rate. The carbon dioxide is formed and driven to the top of the layer of copper oxide by the heat of the blast lamp. Is this period of contact with the copper oxide sufficient for complete oxidation? If so, the rapidity of the passage of oxygen is limited only by the capacity of the potash solution to absorb carbon dioxide rapidly and completely. With solution of 1,400 sp. gr. this capacity is very great.

This plan of having the copper oxide in the crucible has been tried by Dr. Shimer himself who in his original article speaks of an experiment in which the carbon sponge was covered with asbestos coated with copper oxide. The result, however, was a little low. It seemed to the writer to be worth while to do more experimenting in this direction. A new form of large size crucible was used. The ½-hour dried carbon residue and asbestos felt of good thickness, which had previously been transferred (without disturbing its shape) from a Hirsch funnel, smallest size, into a small watch glass for drying, was transferred to the crucible, *carbon side up;*[1] the wad of asbestos used for cleaning out the funnel was placed to one side; both were pressed down evenly on the bottom by a thick glass rod with a spread out end; the crucible was

1. After the last washing of the carbon sponge, some of the copper oxide (3 spoonfuls—smallest size horn spoon) diffused in water was poured on and sucked down.

filled to nearly the point of reaching the inlet tube of the stopper when in position, with finely ground copper oxide freed completely from carbon, and thoroughly tested in this particular by preliminary blank tests; the copper oxide tube was omitted altogether; the blast lamp was used for ignition, and purified oxygen (air should also serve) was used at a 4 or 5-bubble rate, allowing 10 minutes for the combustion; the oxygen was used throughout, and the potash bulb was weighed filled with oxygen.[1] The following results were obtained:

No.	Regular Combustion, 1-Bubble Rate. Carbon, Per Cent.	Shimer Modified, 4 to 5-Bubble Rate. 10-Minute Combustion. Carbon, Per Cent.
3,886	0.85	0.84
3,642	0.96 0.95	0.95 0.96
3,906 S	1.16	1.145
3,819	1.015	1.00
3,921	1.13	1.115
3,818	1.11	1.12 1.115
3,910	1.46 1.46	1.45
3,911	0.79	0.795
3,868	1.005 0.995	0.99
3,954 L 2	1.12	1.105
3,952	0.86	0.85
3,979 S	0.925	0.19
1.03 S	1.03	1.034
3,995	0.90	0.90
3,996	0.925	0.92
3,697	1.24	1.235
3,697 S	1.245	1.245
3,685	0.99	0.98
1.08 Std.	1.08	1.086
3,929	0.765	0.76
3,982	1.06	1.065 1.07
3,989 S	1.04	1.025
3,991	1.005	0.99
3,988 L 2	1.13	1.14

These results, for practical purposes, are very fair indeed. The results are, on the average, 0.007 per cent. low. The doing away with the copper oxide tube is a gain in simplicity.

It was thought that possibly the copper oxide in the crucible, on account of finely ground condition, might act as an absorbent for the chlorine and hydrochloric acid of the carbonaceous residue. The 1.03 carbon standard was determined with the glass bead tube (the hydrochloric acid absorbent) omitted, result, 1.03 per cent., indicating that all the hydrochloric acid and chlorine is absorbed by the finely ground copper oxide, and that the glass bead tube may therefore also be dispensed with. It would, however, require a considerable number of tests to prove conclusively that all the hydrochloric acid is retained in the crucible in every case. In the meantime, it is some gratification to know that the copper oxide at least helps to absorb it.

In the original Shimer method, the asbestos is placed in the crucible, carbon side down. It might be thought that in using this modification in order to insure a complete combustion, it would be well to make the asbestos layer as thin as possible.

The writer at first, in filtering, covered the asbestos with a layer of the copper oxide, and at the end of the filtration scraped off the carbon and copper oxide from the asbestos, and placed these in the crucible directly in the bottom and to one side of the asbestos. But in this plan the volatile portion of the carbonaceous residue seems to be driven off before the copper oxide has become sufficiently heated. Results 0.03 per cent. low were obtained in this way in cases of steel which by the process directed above seem either right, or only 0.015 low. A good layer of asbestos seems, therefore, essential, and the writer also makes it a point not to dry thoroughly previous to combustion, but never longer than ½ hour at 90° C. The copper side is, however, thoroughly dried by a short ignition in a platinum dish or crucible before each combustion.

Besides the results given above, there is other evidence which gives the writer confidence in this process. At these works it is the custom to take two samples from each heat of basic open-hearth steel, determining the carbon (and phosphorus) in each.[2] As these two samples may differ in carbon, a close agreement in the results in any one case proves nothing, with regard to accuracy of method. But many such agreements—one test regular, the other by the Shimer modified—are entitled to be considered as evidence to the accuracy of the latter process. In cases of disagreement and the Shimer result coming low, the latter for a while were repeated by the regular process, and the results of the above table were for the most part obtained in this way.

This plan has now been abandoned on account of risk of getting into "hard" or "soft" spots twice in succession. We now mix together equal weights of drillings from six different samples (pieces of runner) of a heat, and make one combustion.

It is the writer's custom in his daily work to report carbon results in whole numbers or halves, as the case may be, and this custom has been adhered to in this table.

A very great improvement in connection with the carrying out of carbon determinations, and one which once tried will not be abandoned, is Dr. Sargent's plan of rechlorinating the used double chloride solution. There is, however, a source of error connected with its use that deserves to be known.

It would seem that solution of drillings should not be accomplished by allowing to stand at rest over night, except a brisk current of air, or brisk stirring by the machine be first used to drive off free chlorine. A current of air, or brisk stirring, will drive off the chlorine before it has time to do any harm to the separated carbon.

1. This was proposed by Dr. Dudley, who, however, deprecates the use of this plan in important work. In this the writer must disagree with him. But there is a precaution to be observed in this connection. When the bulbs filled with oxygen stand over night they lose weight, probably because of diffusion between the air on the outside and the oxygen within. We have found this loss to be about 0.0001 gram, but it would doubtless vary somewhat in different cases. A correction for this loss must be applied to the first combustion each morning, or, better, the bulbs should be filled with oxygen before use, whenever they stand for some time between successive combustions.

2. In cases of a greater variation than 0.06 per cent. a third sample (or fourth, if necessary) is taken. The average is taken, not of all the samples, but only of the two whose results agree within 0.06 per cent. The other, or others, are ignored, experiments having indicated that they are merely "hard spots" or "soft spots" as the case may be. Our experience is in agreement with Wahlberg's that low and medium carbon steels are more apt to vary than high carbon steels, and that phosphorus is more likely to vary than carbon.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

Mr. Z. T. F. Runner, Secretary and Manager of the Freeport (Ills.) Gas Light and Coke Company, writing under date of the 3d inst., says: "Dear Journal: An item from this 'Neck of the woods' may be of interest to you. To begin with, we have purchased ground on which to erect a new steel tank, storage holder. The year 1902 shows an increase in gas sold of 15 per cent. over the output for 1901. We have reduced our unaccounted-for gas, from 4.80 per cent. in 1901, to 3.20 per cent. for 1902. We have sold over 5 cubic feet of gas for every pound of coal carbonized the past year; we are selling coarse coke at 10 cents per bushel (last year's price) to our home trade, notwithstanding we have been offered 50 per cent. more for our entire output by outside parties."

Mr. F. N. Morton has resigned the position of Superintendent of the Hoboken District of the Hudson County (N. J.) Gas Company in order to assume a responsible position in the home offices of the United Gas Improvement Company.

The proprietors of the Wallingford (Conn.) Gas Light Company have filed with the Secretary of State a petition to the General Assembly, asking permission to increase their capital stock for the purpose of extending the Company's service into North Haven.

It is understood that the plant and franchises of the Isabella Gas Company, of Frederick, Md., have been purchased by a Philadelphia syndicate. The plant has been operated for some time under a lease-hold held by Mr. Marcus R. Williams.

The Welsbach Light Company, of Philadelphia, has brought suit in the United States Circuit Court against the Capital Mantle Company for infringement of the Welsbach patent, No. 563,524, dated July 7th, 1896. The damages are put at $50,000.

The authorities of Duluth, Minn., who are operating the local gas plant, have announced a reduction in the selling rate to $1 per 1,000 cubic feet; equivalent to a concession of 25 cents per 1,000 on illuminating account, and 15 cents per 1,000 on heating and power supply.

Advices by way of Rutland, Vt., are to the effect that the Consolidated Lighting Company, of Montpelier, Vt., has decided to give up the making of gas, one of the principal reasons urged for the discontinuance being the Company's inability to purchase coke. The proprietors say that the Company has been making gas at a loss for months to accommodate customers, and between January 10th and February 1st, Montpelier will be without gas. In February the new Capital Gas Company, which has put in a plant at a cost of $70,000, will begin operating.

The Ambler (Pa.) Gas Company's plant will be erected at Fort Washington. The President of the Company is Mr. John S. Buchanan.

The following circular, issued some time ago under authority of Mr. C. H. Nutting, Superintendent of the Chicopee (Mass.) Gas Light Com-

pany, explains itself: "The State Gas Commissioners have recommended that after January 1, 1903, we shall charge for our gas a price not exceeding $1.50 net per 1,000 cubic feet. We have carefully considered the matter and have decided to do still better than the Commissioners have recommended, and shall put into effect January 1, 1903, a scale of prices ranging from $1.50 to $1.25 net, as follows:

	Cubic Feet Per Month.	Net Rate per 1,000.
Parties using from	100 to 1,900	$1.50
" " "	2,000 " 2,900	1.45
" " "	3,000 " 3,900	1.40
" " "	4,000 " 4,900	1.35
" " "	5,000 " 5,900	1.30
" "	6,000 or over	1.25

"The gross price of gas will be $1.70 per 1,000 cubic feet, and we positively will not allow any discounts after the 10th of each month. The price of gas will be the same, whether used for fuel or illuminating purposes, and only one meter for each customer will be used. You will readily see by the above scale of prices that the more gas you use the cheaper you will get it per 1,000 cubic feet."

THE Queens Borough Gas and Electric Company, of Rockaway, L. I., has filed with the Clerk of Queens County a mortgage and deed of trust for $2,000,000 to the Guaranty Trust Company to secure an issue of an equal par value of bonds. The interest rate is 5 per cent.

A RECENT issue of the New Haven (Conn.) *Register* had this to say: "The annual meeting of the shareholders in the New Haven Gas Light Company was held at the offices of the Company the morning of the 3d inst. There was a large attendance of stockholders. During the meeting President Charles H. Nettleton made an interesting statement to the stockholders concerning the work of improvement in progress on the plant of the Company since the last meeting. At the meeting a year ago authority was voted for large expenditures of money for the purposes of improvement. Under President Nettleton's direction these improvements have been pushed forward and are now approaching completion. One of the important works of development was the extension made in the pipe line. The service of the Company has been extended to Woodmont, requiring the laying of 7 miles of pipe line. A new building erected for the purpose of manufacturing water gas has been finished. President Nettleton reported that a contract had been made with the Riter-Conley Company, of Pittsburg, Pa., for the construction of a gasholder with a capacity for 2,000,000 feet of gas. This holder is to be located on the Company's property on East street opposite the plant of the L. Candee Rubber Company. The holder will be completed during the year. The election for Directors resulted in the following choices: Pierce N. Welch, Charles R. Ingersoll, George J. Brush, Francis Wayland, George D. Watrous, Robert A. Brown, A. H. Robertson, W. J. Trowbridge and Chas. H. Nettleton."

THE New York and Richmond Gas Company, of Staten Island, N. Y., has made application to the New York Stock Exchange to list $1,000,000 of its first mortgage, 5 per cent. bonds.

AT a special meeting of the Directors of the Hartford (Conn.) City Gas Light Company the resignation of Judge Nathaniel Shipman from the Board was accepted. His son, Mr. Arthur L. Shipman, junior member of the prominent local law firm of Gross, Hyde & Shipman, was chosen to fill the vacancy. Judge Shipman had served on the Board for 20 years, and his retirement was prompted solely by continued ill health.

MR. W. M. ADAMS has been appointed Manager of the Fremont (O.) Gas, Electric Light and Power Company, vice Mr. M. J. Dowling, resigned.

THE gas and electric interests of Greenville, Mich., have been purchased by a combination in which Messrs. Henry Idema and W. C. Winchester, of Grand Rapids, Mich., are largely interested.

MR. E. C. WHITE formerly local Manager, at Asbury Park, of the Consolidated Gas Company, of New Jersey, and more recently in the service of the Western Gas Construction Company, of Fort Wayne, Ind., has been appointed Superintendent of Works of the Consolidated Gas Company. His headquarters will be at Long Branch, N. J.

THE people in control of the Chicago Heights (Ills.) Gas Company assert that a works for the supply of gas to the place named will be constructed this spring.

A DETROIT (Mich.) combination has applied to the authorities for the right to construct and operate a gas works in Ironwood, Mich. The Company asks to be allowed to sell gas on illuminating account at $1.75 per 1,000 cubic feet, and on fuel account at $1.25.

MESSRS. ED. WATKINS, J. E. Annis, W. P. McBroon, J. P. Hoskins and C. V. Brown, as projectors of the Consumers Gas Company, have applied to the authorities of Chattanooga, Tenn., for the right to supply gas in that city and its suburbs. They agree that the maximum selling rate demanded by them shall not exceed $1 per 1,000 cubic feet.

PRIOR to his leaving for his new field of duty in Philadelphia, Mr. F. N. Morton, whose resignation of the place of Superintendent of the Hoboken division of the properties of the Hudson County (N. J.) Gas Company, is noted earlier in these items, was the guest of honor at a complimentary dinner tendered him by several of his former associates. The scene of the festivities was the Café Martin, New York, and the session was a most enjoyable one in every sense.

THE North Bay (Can.) Gas Company has been incorporated by Messrs. J. W. Nay, J. A. Burgess and Jesse Bradford. The concern is capitalized in $45,000.

MR. G. A. LANE, General Manager of the Oneonta (N. Y.) Light and Power Company, has been empowered to notify the residents of the district that the selling rate has been put at $1.75 per 1,000 cubic feet, the concession to date from the 1st inst.

AT the organization meeting of the Vicksburg (Miss.) Gas Company the following officers were elected: Directors, E. S. Butts, H. C. McCabe, E. C. Carroll, W. T. Rose, Lee Richardson, C. C. Floweree and J. B. Cowan; President, E. S. Butts.

CONSTRUCTION work on the gas plant for Honolulu, Hawaiian Islands, is underway.

THE South Bend (Ind.) Gas and Fuel Company has put the selling rate for all purposes at $1 per 1,000 cubic feet.

THE Milwaukee Gas Light Company has selected a list of 63 druggists in the city to act as the Company's agents in the collection of bills. The city is divided into 3 collection districts, and it is claimed by the Company that under the new system customers will be saved an aggregate of $5,000 a year. The making of the new list is a decided departure from the former plan, the Company now dealing directly with the druggists as agents, instead of through the Express Company as before. No fee for collection will be charged in the future.

IN the last week in December Superintendent W. P. Knowles, of the Richmond (Va.) City Gas Works, prepared for a local paper the following figures respecting that branch of the city's enterprise for the year 1902: The manufacture and consumption of gas for the year amounted to about 26,000,000 cubic feet more than for 1901. The quantity of coal used in the manufacture of this gas was 8,565 tons; total quantity of gas oil used, 1,018,600 gallons; total quantity of coke used, 12,528,300 pounds; meters in use, 8,269; introduced for new consumers, 373; meters taken out, 593; meters reset, 380; meters repaired and repainted, 1,264; street mains laid during the year, 12,173 feet; laid to date, 81 miles, 4,812 feet; changed location of 54 street lamps; street lamps to date, 1,644; in use, 646; service pipes renewed and repaired, 735; new drips put in, 25; gas stoves put in during the year. 1,010, and 563 arc electric lights in use. The following statement shows the operation of the gas works for the year, the figures for the last few days being estimated:

1902. Months.	Cubic Feet Gas Made.	Cubic Feet Gas Consumed.
January	29,476,300	29,420,166
February	26,731,000	26,776,334
March	24,835,000	24,844,586
April	22,361,500	22,258,443
May	19,833,000	19,840,157
June	16,848,500	16,880,767
July	16.929,700	16,908,693
August	17,919,300	17,933,652
September	21,289,500	21,274,073
October	28,938,300	29,071,265
November	33,299,200	32,152,539
December	38,972,500	39.031,675
Total	297,374,800	297,398,352

THE shareholders of the Springfield (Mass.) Gas Light Company have been notified that those of record, July 19, 1902, are entitled to subscribe for the new stock issue recently allowed by the Massachusetts Board of Gas and Electric Light Commissioners. The right to subscribe will cease next Thursday.

THE public sale of the Etna and Sharpsburg (Pa.) Gas Company will take place to-morrow.

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England—Aug. Siegle, 30 Lime Street, London.

MONDAY, JANUARY 12, 1903.

The Market for Gas Securities.

There was much animation in the trading in local gas shares last week, Consolidated having sold above 222. The closing to-day (Friday) was made at 218½ to 220. The annual meeting of the Company will be held the afternoon of the 26th inst., and there is no reason for anticipating any change of moment in the personnel of its management. The planning for the new works at Astoria is in a forward stage.

Brooklyn Union is featureless, as far as actual sales are concerned, and the same may be said as to the nominal quotations, which are like those of a week ago. Quotations for Peoples, of Chicago, reflect the growth of that concern in real value, and the reported figures are well below its book worth. Baltimore Consolidated was steadily inquired for during the week, and an increase of a point is the result of the trading. This stock is easily worth 80. Washington (D. C.) gas is 394 bid. The general market for gas shares is all on the side of the holder.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.

JANUARY 12.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$73,177,000	100	218½	220
Central Union, Bonds, 5's	3,000,000	1,000	110	112
Equitable Bonds, 6's	1,000,000	1,000	105	..
" 1st Con. 5's	2,300,000	1,000	118	120
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	350	..
Municipal Bonds	750,000	..	..	..
New Amsterdam Gas Co.. Bonds, 5's	11,000,000	1,000	112¼	113
Northern Union, Bonds, 5's.	1,250,000	1,000	108	110
New York and East River Bonds 1st 5's	3,500,000	1,000	112	113
" 1st Con. 5's	1,500,000	..	109	111
Standard	5,000,000	100	130	140
Preferred	5,000,000	100	150	160
Bonds, 1st Mortgage, 5's	1,500,000	1,000	115¼	118
Yonkers	299,550	500	130	..
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	225	235
" " Bonds (5's)	15 000,000	1,000	119	119¼
Bay State	50,000,000	50	1⅝	1¾
" Income Bonds	2,000,000	1,000	.	75
Binghamton Gas Works	450,000	100	28	30
" 1st Mtg. 5's	509,000	1,000	93	96
Boston United Gas Co.— 1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	7½	10
" " Bonds, 5's	5,250,000	1,000	75	77
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000		
Central San Francisco	900,000	..	106	108
Chicago Gas Co. Guaranteed Gold Bonds	7,650,000	1,000	104	104¼
Cincinnati Gas & Elec. Co..	29,500,000	100	99½	101
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	101	101½
Columbus (O.) Gas Lt. & Heating Co	1,682,750	100	88¾	89¼
Preferred	3,026,500	100	107½	1
Consumers, Jersey City Bonds	600,000	1,000	103	106
Consumers, Toronto	1,700,000	50	218	225
Consolidated, Baltimore	11,000,000	100	72	72¼
Mortgage, 6's	3,600,000	..	..	115
Chesapeake, 1st 6's.	1,000,000	..	..	..
Equitable, 1st 6's.	910,000	..	..	..
Consolidated, 1st 5's	1,490 000	..	.	112
Consolidated Gas Co. of N.J.	1,000,000	100	15	17
" Con. Mtg. 5's	880,000	1,000	85	87
Consolidated G. & E. Co.'s. Little Falls, N.Y.	90,000	100	..	100
Bonds	75,000	..	..	100
Detroit City Gas Co	4,825,500	50	.	89
" Prior Lien 5's	5,603,000	1,000	99½	100
Detroit Gas Co., 5's	1,000,000	1,000	77	79
" Inc. 5's	16,000	100	94	94½
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Essex and Hudson Gas Co.	6,500,000	..	34	38
Fort Wayne	2,000,000	..	.	.
" Bonds	2,000,000	..	55	..
Grand Rapids Gas Lt. Co. 1st Mtg. 5's	1,225,000	1,000	104½	105
Hartford	750,000	25	245	265
Hudson County Gas Co., of New Jersey	10,500,000	..	25	..
" Bonds, 5's	10,500,000	..	101	103
Indianapolis	2,000,000	..	..	68½
" Bonds, 6's	2,650,000	..	102	105
Jackson Gas Co	250,000	50	73	75
" 1st Mtg. 5's	290,000	1,000	101	102½
Kansas City Gas Light Co., of Missouri	5,000,000	100	..	36
Bonds, 1st 5's	3,822,000	1,000	102	104
Laclede, St. Louis	10,000,000	100	80	90
Preferred	2,500,000	100	100	110
Bonds	10,000,000	1,000	109½	110
Lafayette Gas Co., Ind.	1,000,000	100		60
Bonds	1,000,000	1,000	60	65
Louisville	2,570,000	50	112	120
Madison Gas & Elec. Co. " 1st Mtg. 6's	350,000	1,000	107½	108½
" 6 per cent. scrip, due 1910	100,000	25	25	87
Montreal, Canada	2,000,000	100	218	184¾
Newark, N. J., Con. Gas Co	6,000,000	..	56	58
Bonds, 6's	4,600,000	..	105	105¾
New Haven	1,000,000	25	300	325
Nashville Gas Lt. Co.	1,000,000	100	110	..
Oakland, Cal.	2,000,000	..	46	47
" Bonds	750,000	..	..	..
Peoples G. L. & Coke Co., of Chicago	25,000,000	100	105½	105¾
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,000	1,000	..	..
2d "	2,500,000	1,000	104	
Rochester Gas & Elec. Co..	2,150,000	50	88	.
Preferred	2,150,000	50	118	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	10,000,000	100	41½	42½
St. Paul Gas Light Co	1,500,000	100	45	47
1st Mortgage 6's	650,000	1,000	113	116
Extension, 6's	600,000	1,000	112¼	115
General Mortgage, 5's	2,465,000	1,000	92	93
St. Joseph Gas Co. " 1st Mtg. 5's	751,000	1,000	95	96½
Syracuse, N. Y.	1,975,000	100	29	..
Bonds	2,047 000	1,000	99½	100
Washington, D. C	2,600,000	20	393¾	395
First mortgage 6's	600,000	..	..	..
Western, Milwaukee. Bonds, 5's	4,000,000	..	109½	110
Wilmington, Del.	600,000	50	232	..

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DIVIDEND NOTICE.

OFFICE OF THE UNITED GAS IMPROVEMENT CO.,
N. W. CORNER BROAD AND ARCH STS.,
PHILADELPHIA PA., Dec. 10, 1902

The Directors have this day declared a quarterly dividend of 2 per cent. (one dollar per share), payable Jan. 15th, 1903, to stockholders of record at the close of business, Dec. 31, 1902. Checks will be mailed.

1436-5 LEWIS LILLIE, Treasurer.

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In the manufacture and distribution of coal gas, laying mains and services, handling gas stove trade, repairing and setting meters, and all work pertaining to the business. Best of references.

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By a young man having 13 years' experience in coal and water gas manufacture and distribution. Thoroughly competent and conversant in all details. A-1 references.

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Wanted, Position

As General Bookkeeper with a Gas Company,

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In city of not less than 80,000 people. Can show a record of having done something in this line. Gas experience of over 12 years.

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Young man of thorough experience in every department of the business. Can guarantee results in manufacturing, and can instil the necessary energy into the hunt for new business. Good record and excellent references.

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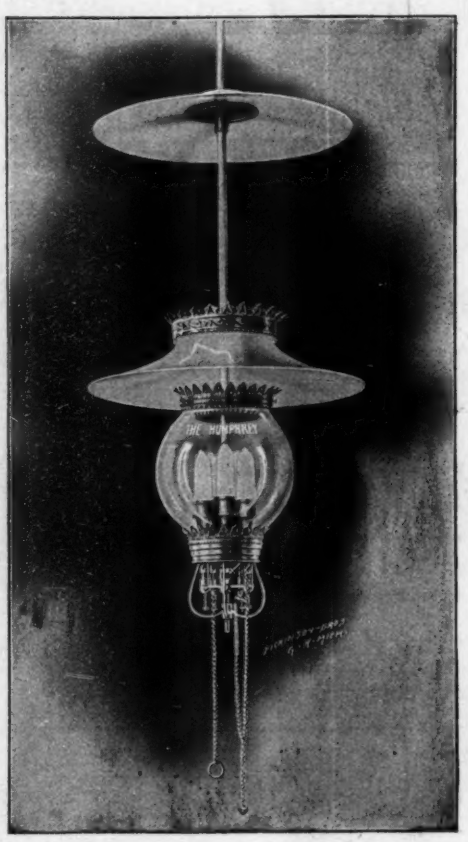

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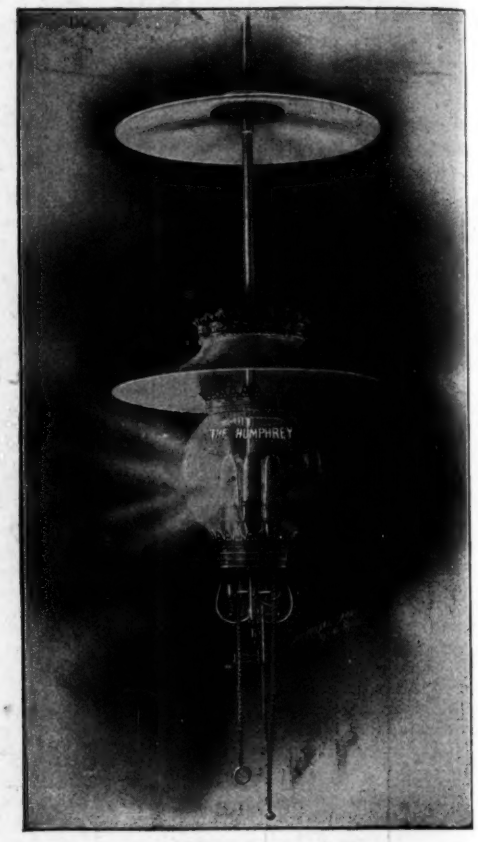

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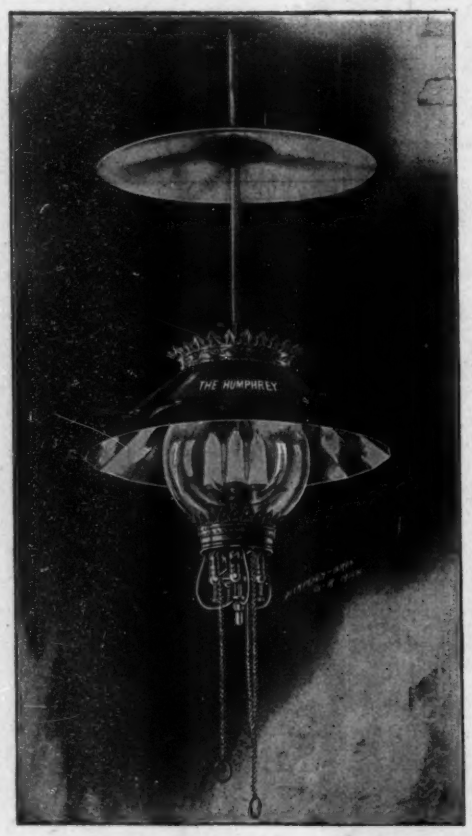

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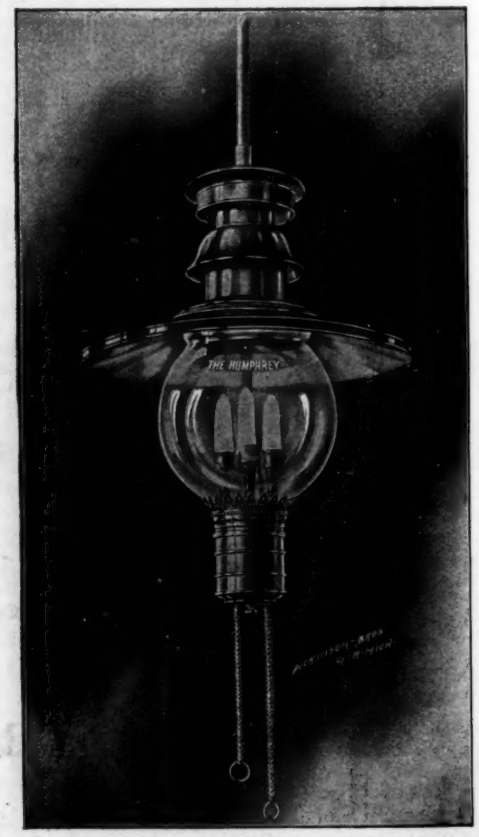

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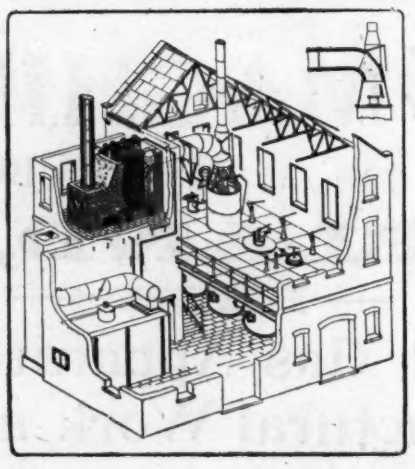

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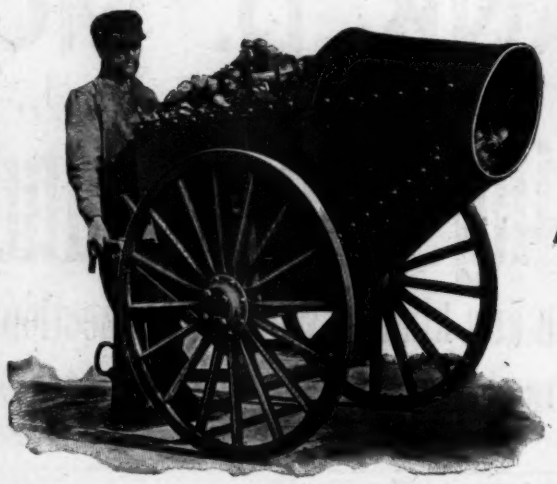

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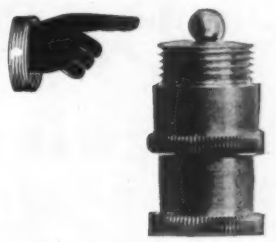

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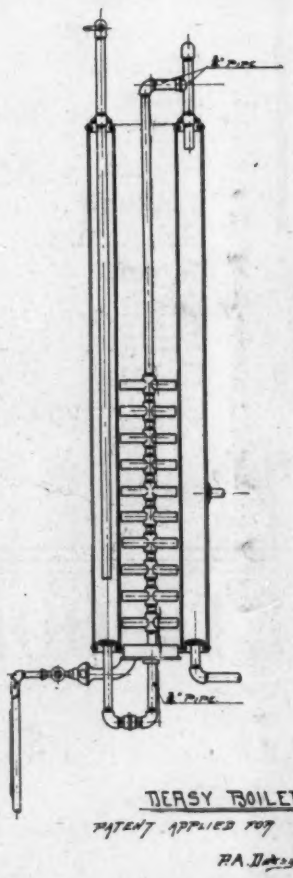

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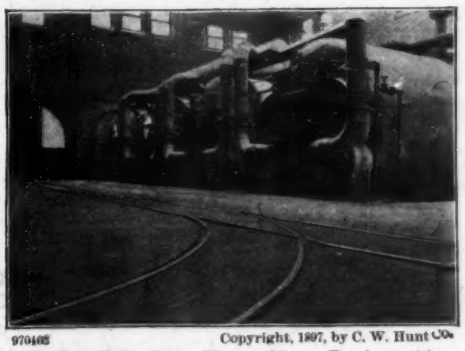

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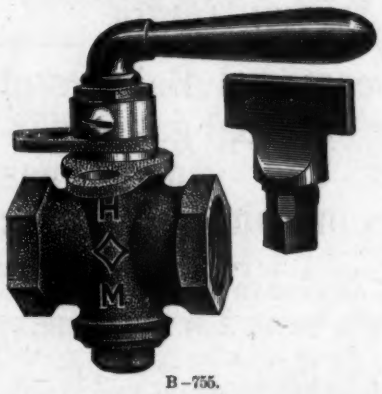

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TOO little is not as much as you pay for, and too much is more paid for than you need.

In **Mueller Gas Cocks** you find a happy medium--not so little metal as to leave them weak, nor yet so much as to make them costly.

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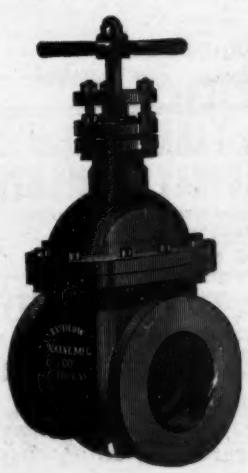

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This Computer solves the following formula, which is applicable to Gas, Air and other elastic fluids, flowing through long pipes with high initial pressures:

Discharge in cubic feet per hour at atmospheric pressure $= 33.3 \sqrt{\frac{d^5 \times (p_1^2 - p_2^2)}{L \times w}}$

Where

d = diameter of pipe in inches,

p_1 = absolute initial pressure in pounds per square inch,

p_2 = absolute terminal pressure in pounds per square inch,

L = length of pipe in miles,

w = specific gravity of the fluid when air = 1.

To Find the Discharge from a Pipe and the Required Size of Pipe.

(1.) Set the specific gravity of the fluid opposite the length of pipe;

(2.) Bring the DIFFERENCE of the initial and terminal gauge pressures opposite the SUM of the initial and terminal gauge pressures;

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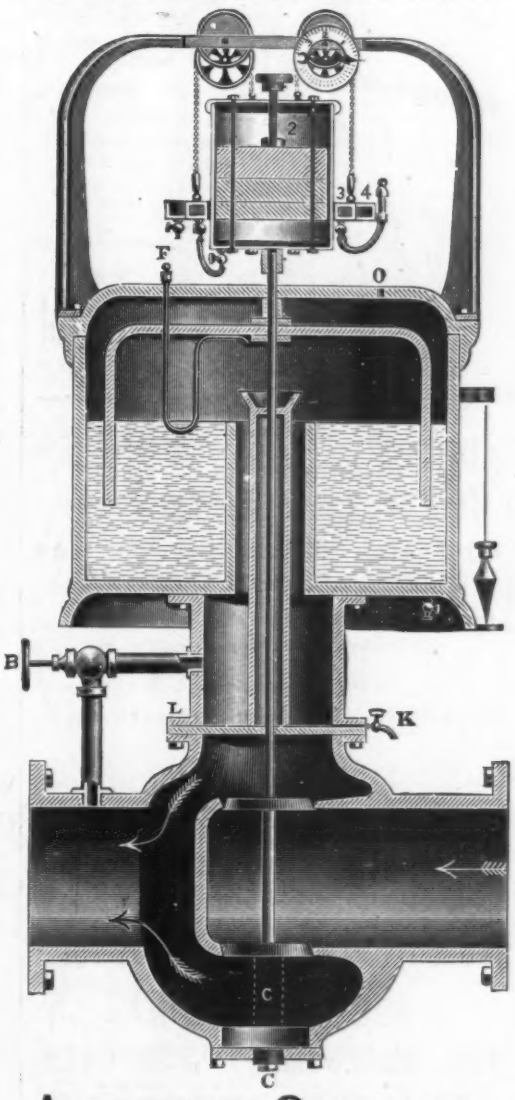

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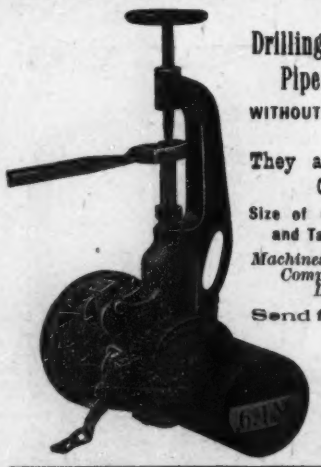

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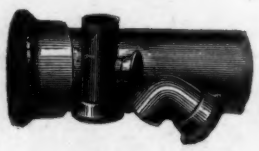

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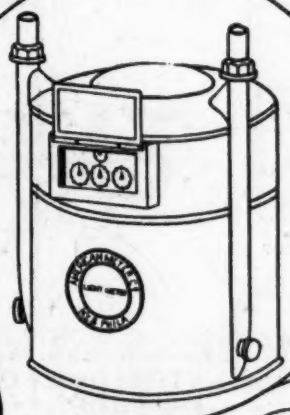
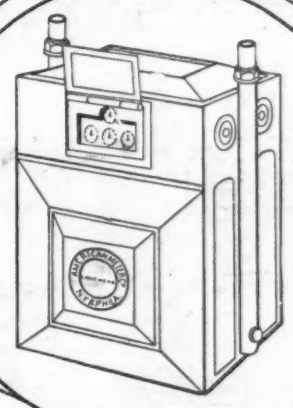
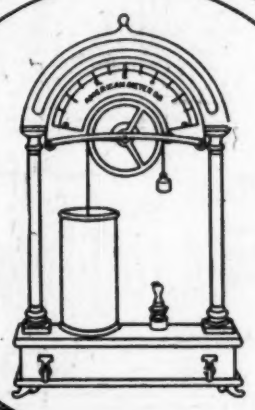
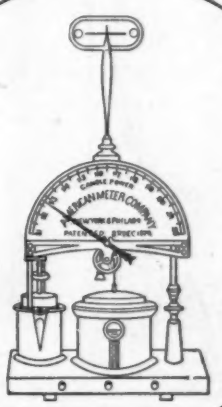




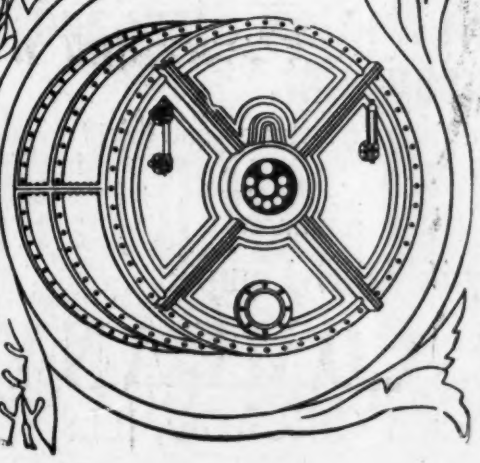


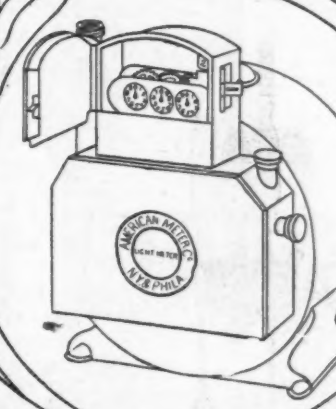


PUBLIC LIGHTING TABLE.

JANUARY, 1903.

Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Table No. 1. Following the Moon. Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Table No. 2. New York City. All Night Lighting. Extinguish.
				P.M.	A.M.
Thu.	1	5.10 PM	6.20 AM	4.30	6.30
Fri.	2	5.10	6.20	4.30	6.30
Sat.	3	8.30	6.20	4.30	6.30
Sun.	4	9.30	6.20	4.30	6.30
Mon.	5	10.30	6.20	4.30	6.30
Tue.	6	11.40 FQ	6.20	4.30	6.30
Wed.	7	12.40 AM	6.20	4.30	6.30
Thu.	8	1.50	6.20	4.40	6.30
Fri.	9	2.50	6.20	4.40	6.30
Sat.	10	4.00	6.20	4.40	6.30
Sun.	11	5.00	6.20	4.40	6.30
Mon.	12	No L.	No L.	4.40	6.30
Tue.	13	No L. PM	No L.	4.40	6.30
Wed.	14	No L.	No L.	4.40	6.30
Thu.	15	5.30 PM	8.50 PM	4.50	6.25
Fri.	16	5.30	10.00	4.50	6.25
Sat.	17	5.30	11.10	4.50	6.25
Sun.	18	5.30	12.10 AM	4.50	6.25
Mon.	19	5.30	1.10	4.50	6.25
Tue.	20	5.30 LQ	2.10	4.50	6.25
Wed.	21	5 30	3.10	4.50	6.25
Thu.	22	5.30	4.10	5.00	6.25
Fri.	23	5.30	5.00	5.00	6.25
Sat.	24	5.30	5.50	5.00	6.25
Sun.	25	5.40	6.10	5.00	6.25
Mon.	26	5.40	6.10	5.00	6.25
Tue.	27	5.40	6.10	5.00	6.25
Wed.	28	5.40 NM	6.10	5.00	6.25
Thu.	29	5.40	6.10	5.05	6.15
Fri.	30	5.40	6.10	5.05	6.15
Sat.	31	5.40	6.10	5.05	6.15





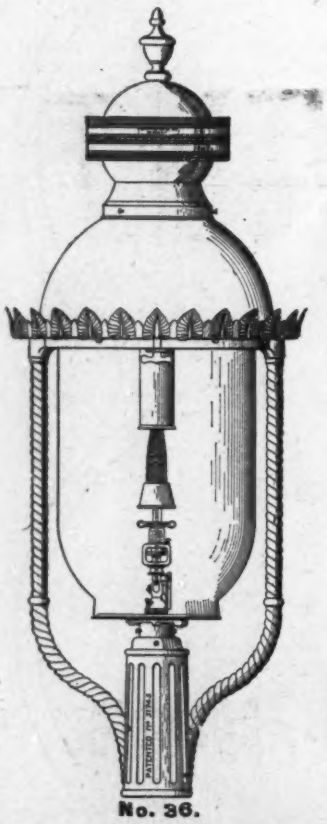
TOTAL HOURS LIGHTING DURING 1903.

By Table No. 1.	Hrs.Min.	By Table No. 2.	Hrs.Min.
January	245.00	January	423.20
February	192.00	February	355.25
March	201.00	March	355.35
April	167.20	April	298.50
May	152.00	May	264.50
June	131.00	June	234.25
July	140.40	July	243.45
August	156.20	August	280.25
September	171.20	September	321.15
October	198.20	October	374.30
November	216.30	November	401.40
December	232.10	December	433.45
Total, yr.	2203.40	Total, yr.	3987.45

NEW YORK, 33 Nassau Street. PHILADELPHIA, Broad and Arch Streets. CHICAGO, Foot of Orleans Street. BOSTON, 624 Tremont Building.
CLEVELAND, 809 Cuyahoga Building. ST. LOUIS, 712 Roe Building. SAN FRANCISCO, 712 Polk Street.

WELSBACH STREET LIGHTING COMPANY

.... OF AMERICA ....



No. 36.

Controls and Operates the

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Which includes its specially DESIGNED AND PATENTED BURNER for STREET and PARK LIGHTING exclusively.

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No. 38.

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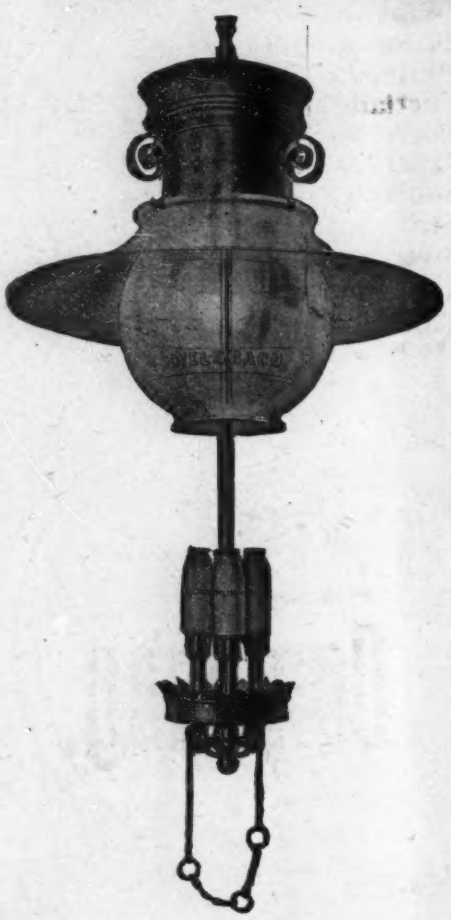

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Evanston, Ills.	New Orleans, La.	Washington, N. C.
Evansville, Ind.	Norfolk, Va.	Woonsocket, R. I.

TOTAL SETS, 1902, ... 51
TOTAL DAILY CAPACITY, 1902, . . 32,825,000 cubic feet.
TOTAL SETS TO DATE, ... 447
TOTAL DAILY CAPACITY, ... 299,670,000 cubic feet.

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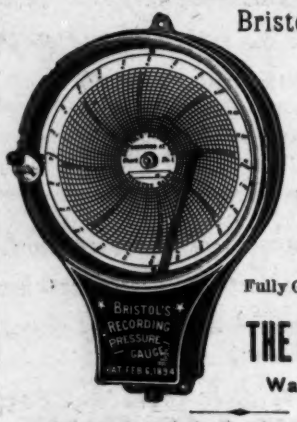

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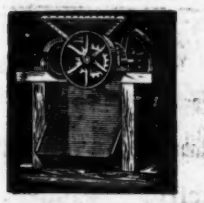

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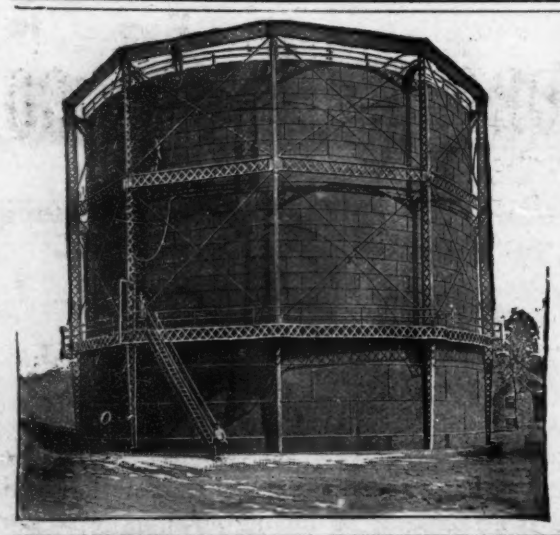

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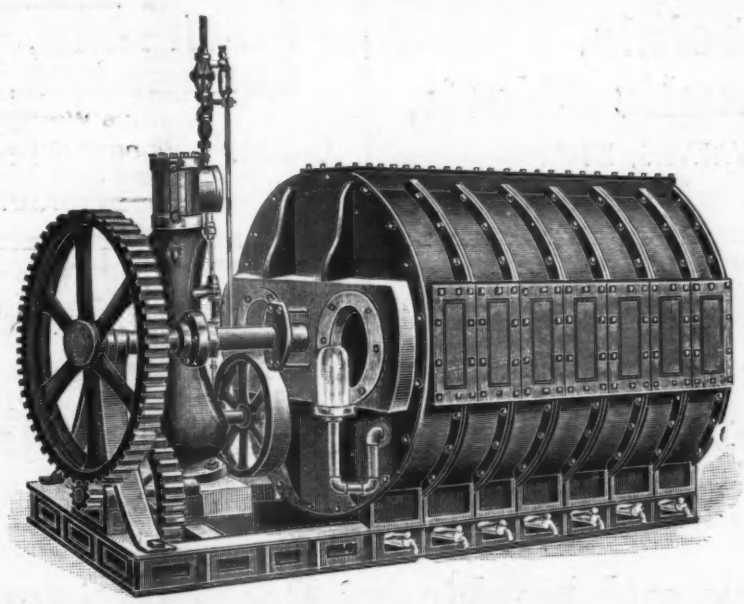

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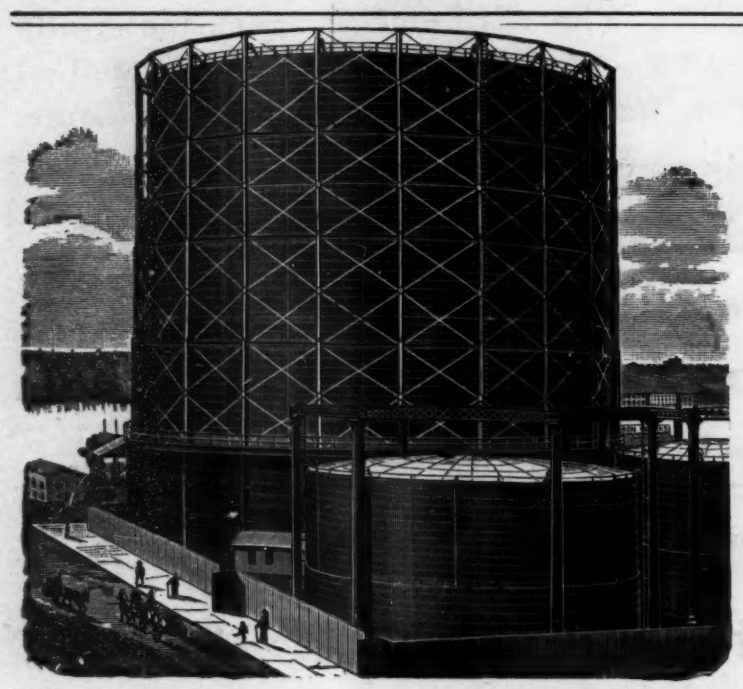

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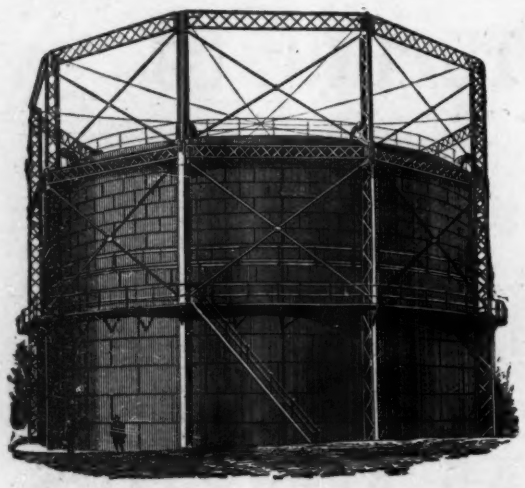

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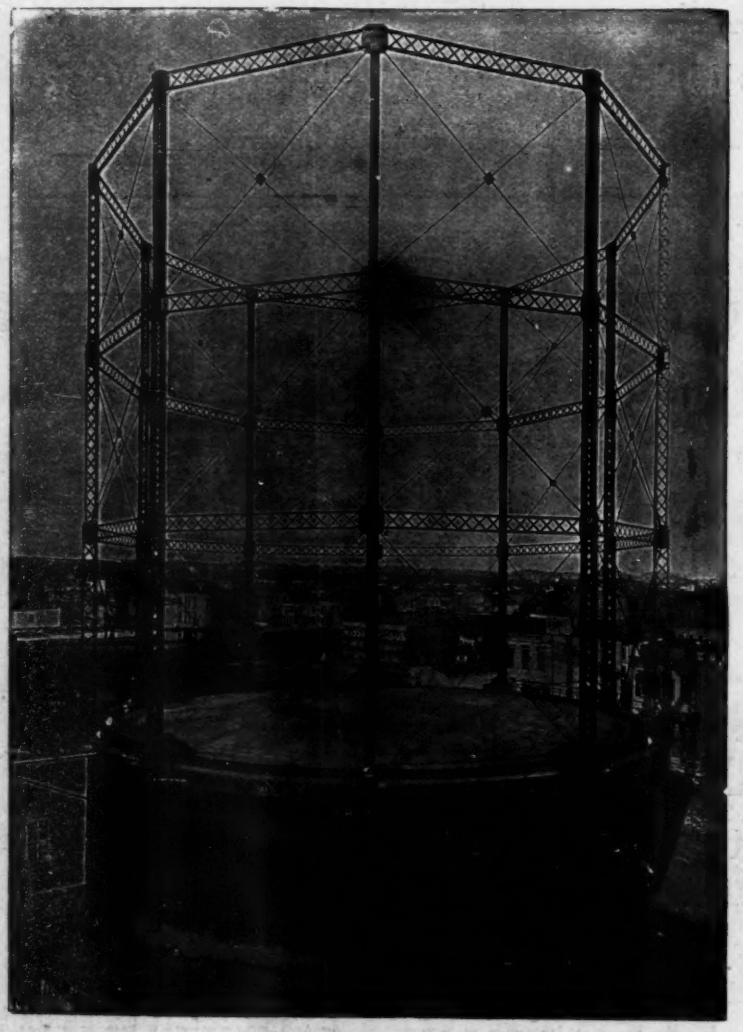

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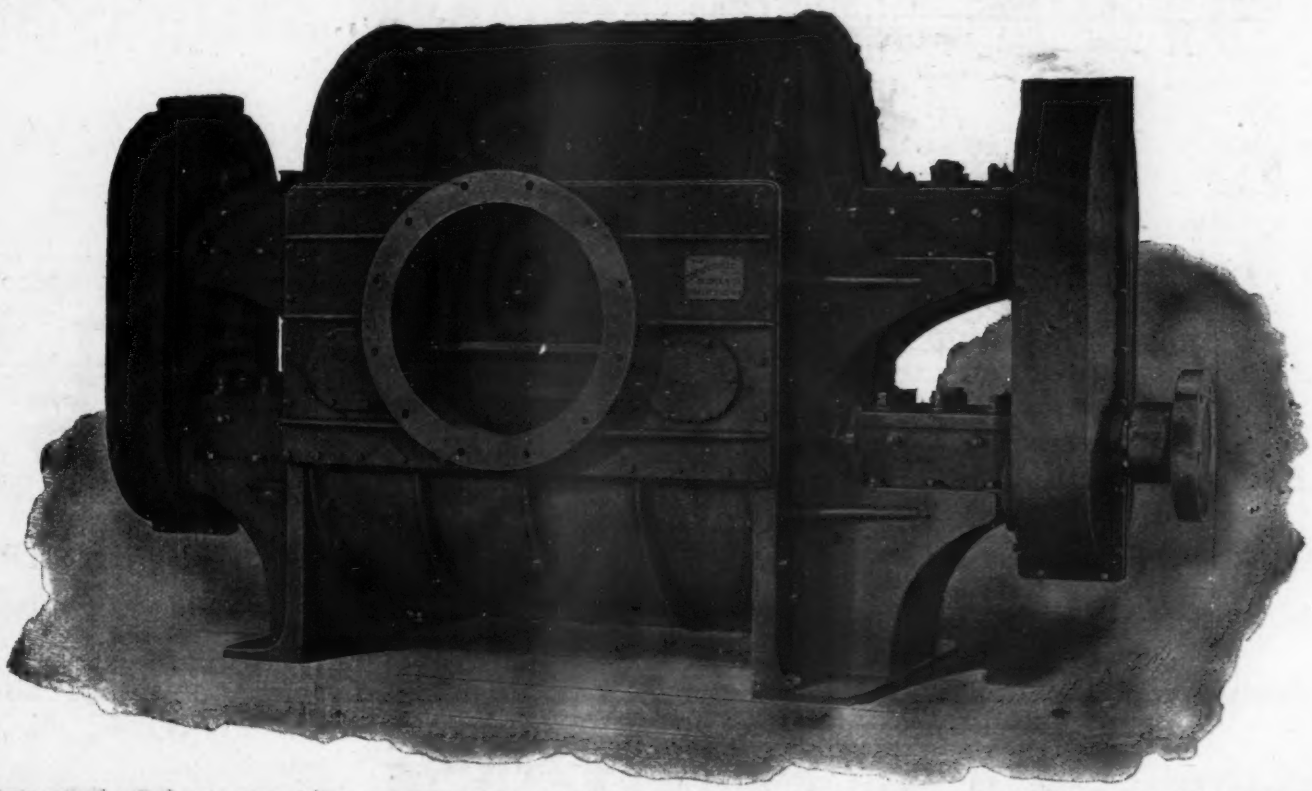

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